Evaluation of the Potential Effect of Chloride Reduction on Turbidity in Lake Kemp for the Red River Chloride Control Project, Tulsa District

by

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CONTENTS

List of Figures

List of Tables

Preface

This study was conducted by the U.S. Army Engineer Research and Development Center (ERDC) at the Waterways Experiment Station (WES) in support of the U.S. Army Corps of Engineers, Tulsa District (TD), Red River Chloride Control Project. The study site was in Northwest Texas at Lake Kemp on the Wichita River, a tributary of the Red River.

The study was conducted by Mr. Stephen A. Pranger of the Environmental Restoration Branch (ERB), Environmental Engineering Division (EED), Environmental Laboratory (EL), ERDC, Dr. Paul R. Schroeder, Special Projects Group, EED, and Dr. Elizabeth C. Fleming of the ERB. Ms. Cheryl M. Lloyd, Environmental Resources Engineering Branch, EED, assisted in data analysis and report preparation. Mr. Steve Nolen of the Planning Division, TD, provided background materials, review of the study plan, and assistance in sample collection. The Environmental Chemistry Branch (ECB), EED, assisted with the chemical analysis of samples under the direction of Ms. Ann B. Strong, Chief, ECB.

The study was conducted under the general supervision of Mr. Daniel E. Averett, Chief, ERB; Mr. Norman R. Francingues, Jr., Chief, EED; and Dr. John W. Keeley, Acting Director, EL.

Dr. Lewis E. Link, Jr. was the Acting Director, ERDC, and Col. Robin R. Cababa, EN, was Commander.

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1 - Introduction

Background

Lake Kemp is a large, brackish impoundment built on the Wichita River, a tributary of the Red River, for flood control and irrigation (Wilde 1999). Lake Kemp also provides recreational activities and potable water to residents in the surrounding area of Baylor County, Texas. The high ionic content of its water, comprised mainly of salts of chloride, sulfate, sodium, and calcium, poses problems for domestic, agricultural, and industrial use and requires expensive potable water treatment processes.

The U.S. Army Corps of Engineers, Tulsa District (TD), has designed a chloride reduction project on the Red River and its tributaries at three areas (Areas 7, 8, and 10) on the Wichita River above Lake Kemp, TX to improve water supply quality (Wilde 1999). The project has been completed at Area 8 and is now being considered at the other two areas. If both projects are implemented, the average total dissolved solids (TDS) concentration in Lake Kemp is expected to decrease further from 1872 mg/L to 902 mg/L (approximately a 45% reduction). The average chloride concentration is expected to fall from 695 mg/L to 211 mg/L while the average sulfate concentration is expected to fall from 567 mg/L to 430 mg/L. The remainder of the decrease in TDS will come mainly from reductions in sodium and calcium. The predicted water quality data are listed in Table 1.

Concerns for the environmental impacts that the Red River Chloride Control Project will present on the water quality at Lake Kemp have arisen. Lake Kemp has a surface area of approximately 15,590 acres and a volume of about 268,000 acre-feet. Lake Kemp is a man-made impoundment of highly mineralized water. The total dissolved solids concentration at Lake Kemp varies seasonally and spatially from about 1300 to 3600 mg/L, with values greater than 2000 mg/L being common during normal and low flow periods. Chloride, sulfate, sodium, and calcium ions constitute about 35, 25, 25, and 10 percent of the dissolved salts, respectively. Executing the chloride control project will decrease the total dissolved solids (TDS) during low to normal flow periods by approximately

Table 1. Pre- and Post-Project Concentration-Duration Data[*]

Duration Concentration Exceeded (percent of time)	TDS Concentration (mg/L)		Chloride Concentration (mg/L)		Sulfate Concentration (mg/L)	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
1	2594	1327	896	316	750	637
5	2481	1203	844	302	718	586
10	2407	1157	809	288	699	552
20	2152	1075	755	258	633	496
50	1872	902	695	211	567	430
80	1597	627	592	161	498	312
90	1468	558	532	128	431	265
95	1419	512	513	110	423	240
99	1353	462	496	98	417	222

[*] from concentration/duration data report provided by USAED Tulsa, May 1999.

Pre = Area 8 Only   Post = Areas 7, 8 & 10

one third of pre-project values. Concern has been raised that this decrease in TDS concentration will decrease the rate of sedimentation and yield more suspended solids and turbidity in Lake Kemp waters. The elevated turbidity could in turn reduce the productivity of the lake, reduce its recreational value, and otherwise impact its environmental quality. Turbidity in Lake Kemp is noticeably higher during high flow periods, the same time when the TDS concentration is much lower due to the higher dilution of the brine flows. Therefore, there is a question as to whether the higher turbidities are due solely to higher flow and its corresponding greater erosion rates, sediment loads, and bed resuspension rates or are in part due to the lower TDS concentration.

Brackish waters induce coagulation of clay suspensions and promote rapid sedimentation, producing very clear water with low turbidities. Experience with sedimentation of dredged material has shown that the salinity required to induce coagulation is in the range of 1 to 3 ppt (1000 to 3000 mg/L TDS) (Montgomery 1978). Higher valence cations such as Ca^{+2} and Fe^{+3} can induce coagulation at even lower concentrations (Cohen and Hannah 1971). Therefore, the proposed change in TDS concentration is possibly sufficient to change the coagulation, the sedimentation rate, and the turbidity of the water. In the absence of field data, laboratory testing provides the best predictor of the impacts of lowering the TDS concentration on turbidity.

The ionic strength of water impacts sedimentation by changing the stability of colloidal particles, in this case clay and other natural detritus. Particles gain stability primarily by electrical forces due to charges on their surface or by hydration forces that provide a hydrophilic surface. TDS reduce the electrical forces by compressing the electrical double layer and decreasing the distance that electrical repulsion forces effectively act. This reduction in electrical forces allows for more frequent collisions between particles that result in coagulation. Then, as coagulation proceeds, the particle flocs grow until they are large enough to settle and overcome Brownian motion. In addition, TDS reduce the hydration forces by competing with the particles for the water. The thickness of the adsorbed water on the particles and the affinity of the particle for water are reduced, permitting easier aggregation of the particles. The change in TDS concentration being proposed is rather small, and therefore, it was impossible to determine the significance of the change without laboratory experimentation.

In support to the Tulsa District, the U.S. Army Engineer Research and Development Center Environmental Laboratory (EL) at the Waterways Experiment Station (WES), Vicksburg, Mississippi, conducted a study on the impact that the Red River Chloride Control Project will have on turbidity in Lake Kemp. The turbidity under a wide range of conditions was measured through time to successfully accomplish the investigation.

Purpose

The purpose of this study was to determine whether the proposed change in the TDS concentration will alter the sedimentation rate as determined by the decay constant in Equation 1 and the residual turbidity as determined by the final turbidity readings from the sedimentation tests. In addition, the study examined whether the initial turbidity levels affect the results. Coagulation theory suggests that the relationship between the number of particles in suspension (as measured by turbidity and/or suspended solids concentration) and time follows the following equation:

$$N = N_o e^{-k t} \tag{1}$$

where N is the number/concentration of particles in suspension at time t; N_o is the initial number/concentration of particles in suspension; and k is the particle decay rate or turbidity removal rate.

The study also examined whether there are gradual trends or sharp breaks in the plots of turbidity versus reductions in TDS. Sharp breaks normally occur in plots of final turbidity versus TDS when the range in TDS concentration contains the critical concentration for coagulation. At concentrations slightly above the critical concentration for coagulation, the decay rate in turbidity increases gradually with TDS concentration until the rate becomes large. At TDS concentrations below the critical coagulation concentration, the change in turbidity should be small and nearly independent of the TDS concentration.

Objectives

The objectives of the Lake Kemp study were:

(1)   to define the possible impact of a reduction in the TDS concentration in the Wichita River on the water clarity (turbidity) at Lake Kemp, Texas;

(2)   to establish a relationship among TDS concentration, turbidity and turbidity decay rate;

(3)   to determine if the variance in the decay rates can be attributed to the impacts of varying TDS concentrations or the initial turbidity using a two-way analysis of variance (ANOVA) with replication;

(4)   to determine if the variance in the 7-day (final) turbidity values can be attributed to the impacts of varying TDS concentrations or the initial turbidity using a two-way analysis of variance (ANOVA) with replication; and

(5)   to determine if the differences in the final turbidity and turbidity decay rate among the different test conditions (various levels of TDS and initial turbidity) are statistically different by comparing the means of the replicates with the Duncan's multiple range test and Student's t-test.

2 - Description of Water Quality Parameters

The following chemical, physical and other common water quality parameters were used in the conduct of this study to rapidly and simply quantify and characterize the water quality and sedimentation processes.

Chemical Parameters

The chemical parameters measured in the study are related to their solubility in water and ionic composition of the water (Clark 1990). Total dissolved solids, alkalinity and hardness are in this group of parameters, as well as individual ions including sodium, calcium, magnesium, potassium, chloride, and sulfate.

Total dissolved solids consist of organic and inorganic molecules and ions present in solution in water. Alkalinity is the capacity of the water to neutralize acids. The most common constituents of alkalinity are carbonate, bicarbonate, and hydroxide ions. High alkalinity imparts a bitter taste to water (Clark 1990). Alkalinity plays an important role in the precipitation of many metal salts and in coagulation by ferric and aluminum salts. Hardness is defined as the concentration of multivalent metallic cations in solution (Clark 1990). The reaction of these cations with the anions present in the water will form precipitates, which will contribute to the deposit of sludge or sediment. Multivalent cations also significantly promote coagulation, contributing to the ionic strength of the solution in quantities greater than the additive effect of its concentration.

Physical Parameters

The definition of physical water quality parameters has its fundamental basis on those characteristics that can be perceived by the human senses. Suspended solids, turbidity and temperature comprise the only physical water quality parameters measured in this study.

Suspended solids consist mainly of organic and inorganic matter common in surface waters, usually detritus of clay and biological solids such as algae. The presence of suspended material in natural water causes the absorbance, reflection or scattering of light. The measurement of the extent of this phenomenon is the turbidity. Turbidity is commonly aesthetically displeasing, but it may also cause environmental impacts. Interferences with the photosynthesis in the water column may occur due to reduced light penetration. Interference with aquatic life may also occur through feeding and/or respiratory problems. Increases in turbidity at Lake Kemp could potentially reduce the lake's productivity, thereby reducing fish population. Temperature affects the kinetic energy of the particles undergoing Brownian motion and, as such, impacts the turbidity decay rate as well as chemical reaction rates.

3 - Technical Approach

The development and accomplishment of the study were completed in three phases:

Phase 1:   Site water collection, water characterization, and suspension preparation.

Phase 2:   Bench study of the impact of TDS concentration and initial turbidity on the turbidity as a function of time.

Phase 3:   Data reduction and statistical analyses, including two-way ANOVA with replication and comparison of means by the Duncan's multiple range test Student's t-test.

Phase 1: Sample Preparation

Site Water Collection

Mr. Steve Pranger, EL, Mr. Steve Nolen, TD, and Texas Tech University personnel collected approximately 200 gallons of water at Lake Kemp during the morning hours of July 14, 1999. Water was collected at a depth just below the surface in the western portion of Lake Kemp (Figure 1). The sampling location was near the Wichita River tributary and in an area of high turbidity. The area was just southwest of Cattle Island.

Several water parameters were measured at the site; they are summarized in Table 2. In addition, the Secchi depth was measured to be 1.1 meters. Water samples were also collected in 250-mL nalgene bottles at the site to be used for chemical analyses upon arrival at WES. The water was transported to WES by Mr. Pranger in four 55-gal plastic barrels and stored in a walk-in cooler at 4 C until the start of the study.

Table 2. Lake Kemp On-Site Water Parameters

Parameter	Depth (meters)	
	0.5	3.0
Temperature (C)	20.08	16.66
Dissolved Oxygen (mg/L)	8.20	8.10
Conductivity (mS/cm)	2.67	2.69
pH	8.24	8.21
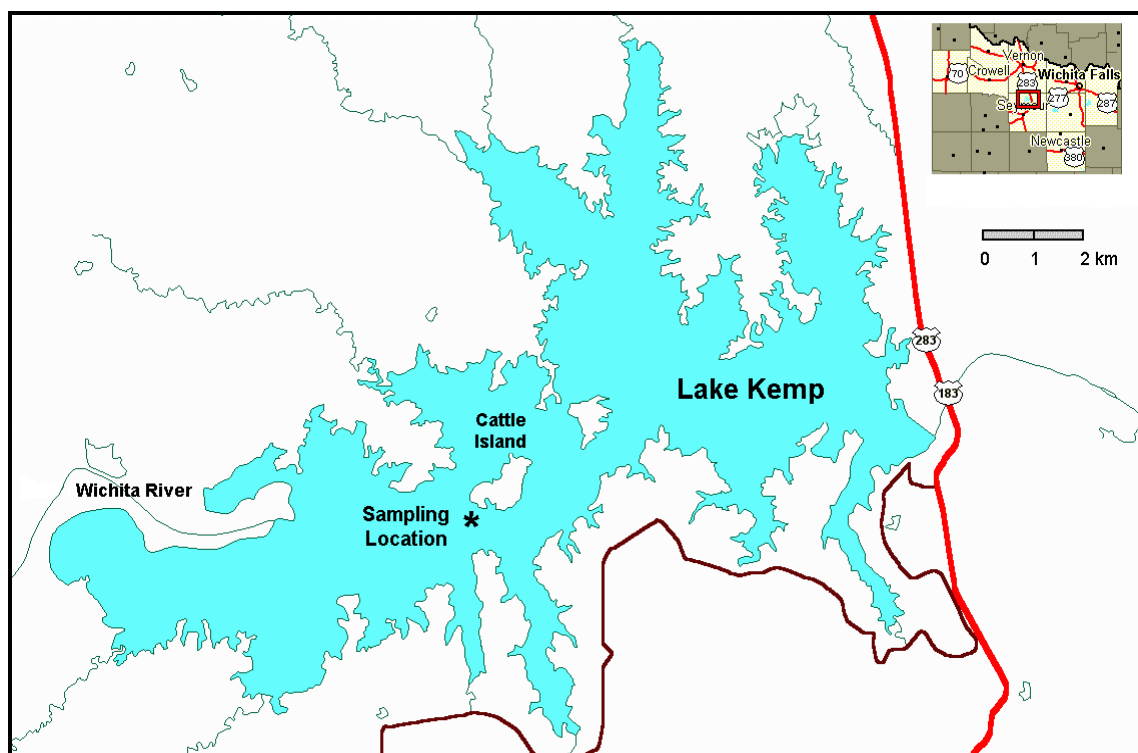
Figure 1. Lake Kemp site map.

Water Characterization

Chemical analyses of the 250 mL samples were performed to characterize the ionic composition of the site water. The chemical analyses, which included chloride, sulfate, potassium, sodium, magnesium, calcium, total hardness, and alkalinity, were performed by Environmental Chemistry Branch (ECB) personnel and is described briefly in the Materials and Methods section. Physical water characteristics, including turbidity and total suspended solids, in addition to total dissolved solids, pH, and conductivity, were measured and recorded by Environmental Restoration Branch (ERB) personnel. Table 3 presents a summary of these analyses. The ECB laboratory raw data sheets for these analyses and for other chemical analyses presented in this report are included in Appendix D.

Suspension Preparation

After 7 days of settling, 90 percent of the supernatant was decanted from each barrel. The remaining ten percent of the suspension containing the settled material from the bottom of the four 55-gallon barrels was stored in another 55-gallon plastic container. After 7 more days of settling, the supernatant was decanted again. The remainder was poured into two 5-gallon buckets for preparation of the stock turbidity suspension.

Table 3. Lake Kemp Water Characterization

Parameter	Sample ID			Mean
	Kemp-001	Kemp-002	Kemp-003	
Chloride (mg/L)	1219	1218	1218	1218
Sulfate (mg/L)	1073	1073	1079	1075
Potassium (mg/L)	6.78	8.43	7.81	7.67
Sodium (mg/L)	629	673	640	647
Magnesium (mg/L)	64.2	71.1	69.8	68.4
Calcium (mg/L)	230	247	232	236
Total Hardness (mg/L of $CaCO_3$)	839	910	867	872
Alkalinity (mg/L of $CaCO_3$)	88.8	85.9	86.2	87.0
Total Dissolved Solids (mg/L)	2884	2902	2884	2890
Total Suspended Solids (mg/L)	7	6	8	7
Conductivity (μMHOS/cm)	1100	1140	1130	1123
Turbidity (NTU)	5.5	5.5	3.5	4.8
pH	8.21	8.27	8.27	8.25

Phase 2: Bench Study

Sedimentation tests were conducted in 4-liter cylinders in groups of five. Each group contained three replicates using an initial turbidity of 8 NTU and two replicates using an initial turbidity of 24 NTU. Each group of five sedimentation tests contained one set of tests at each of the following eight TDS concentrations: 2900, 1857, 1592, 1320, 1050, 900, 750, and 600 mg/L. These TDS concentrations correspond to the initial TDS concentration (control), transition concentrations, and the TDS concentrations that are expected to be exceeded approximately 1%, 20%, 50%, 70% and 85% of the time following implementation of the chloride reduction project. In addition, a test using all eight TDS levels was performed using a very high initial turbidity of about 43 NTU without replicates.

Using the chemical analysis results and a fixed amount (667 mL) of stock suspension and/or supernatant, a chemical ionic balance was performed for each of the TDS levels. In order to achieve these TDS concentrations, stock materials from Lake Kemp were diluted with distilled, de-ionized (DDI) water. Various amounts of chemical solutions were then added resulting in 4 liters of suspension with the required TDS and turbidity levels (Table 4). Standard chemical solutions of fixed concentrations were prepared using anhydrous chemicals and DDI water.

Table 4. Lake Kemp Suspensions

Target TDS Level (mg/L)	Volume Added of Each Material to Prepare 4-L Suspension Having Target TDS Level (mL)					
	Sodium Chloride, 10 g/L NaCl	Sodium Sulfate, 10 g/L Na$_2$SO$_4$	Calcium Chloride, 10 g/L CaCl$_2$	Magnesium Sulfate, 10 g/L MgSO$_4$	Lake Kemp Stock Suspension & Supernatant	DDI
600	37	119	0	96	667	3078
750	43	67	0	164	667	3056
900	18	50	18	232	667	3012
1050	32	139	40	232	667	2887
1320	89	157	91	232	667	2761
1592	148	169	165	232	667	2616
1857	193	224	220	232	667	2461
2900	0	0	0	0	4000	0

Calculation of the quantity of chemicals to be added for each different TDS level was based on the previous chemical analysis of the natural water, the target TDS concentrations, the target chloride concentration, the target sulfate concentration, and the resulting ionic balance. The control cylinder (2900 mg/L TDS) was diluted with supernatant, reproducing the natural water condition. Resuspension and dispersion of the stock turbidity solution was accomplished by mixing, followed by ultrasonic treatment, which increased turbidity of the stock suspension by approximately ten units (about 30%).

Each group of the eight different TDS conditions was prepared similarly according to the following steps:

1. Pour the required amount (Table 4) of DDI water into the 4-L cylinder.
2. Add the required amounts of the 4 chemical solutions into the cylinder.
3. Stir up stock turbidity solution and pour 667 mL into 1-gallon glass jar.
4. Mix stock using ultrasound treatment; 5 mins at frequency of 20 MHz.
5. Combine sonicated stock and chemical/DDI solutions in cylinder.
6. Mix cylinder contents thoroughly by pouring back and forth (3 times) between containers.

The mixing of the chemical/DDI solution and the sonicated stock solution marked test start with test duration totaling seven days. Throughout the test period, turbidity was measured and

recorded at specific intervals: 3, 6, 12, 24, 48, 72, 96, 120, 144, and 168 hours. Samples were collected by pumping about 100 mL through a glass tube and Tygon tubing from a depth of 500 mL (approx. 4 inches) below the water surface. Turbidity of the sample was then measured and recorded. Figure 2 shows the bench scale setup.
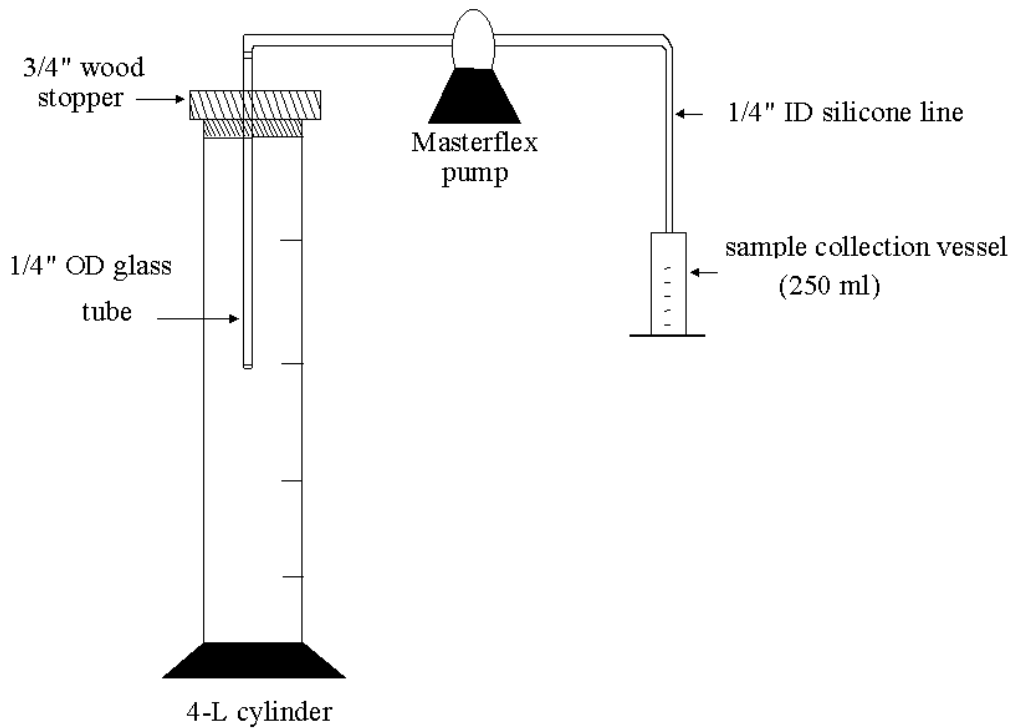
Figure 2. Lake Kemp bench scale laboratory study setup.

Phase 3: Data Reduction and Analyses

The turbidity data for each treatment and replicate was reduced in several manners for later statistical analyses. First, the data was regressed in the form of Equation 1 to determine the turbidity decay rate of each replicate for all treatments. The mean turbidity and standard deviation of the replicates were computed for each treatment and time period.

Using the reduced data, two-way ANOVA with replication was performed on the computed turbidity decay (sedimentation) rates to determine whether the variances in the data were attributable to the treatments or simply error and whether the differences between treatments were statistically significant. In this test TDS concentration and initial turbidity

were the two treatments, and the replicates provided a measure of errors. Upon demonstrating that the effects of initial turbidity were statistically significant, an one-way ANOVA test was run twice, once on the computed turbidity decay rates for test conditions having an initial turbidity of 8 NTU and the other on the computed turbidity decay rates for test conditions having an initial turbidity of 24 NTU. These analyses were run to determine whether the mean values of the replicate turbidity decay rates at the various treatment levels were statistically different. The decay rates between the two different initial turbidity conditions at the same TDS concentration were compared using Duncan's multiple range test and Student's t-test. These same procedures were used on the final turbidity values (after 7 days of settling).

4 - Materials and Methods

Materials

This section contains a brief description of the equipment and chemicals used during the study.

Equipment

Cole-Palmer Masterflex peristaltic pump Model 75553-70 was used to pump out the filtrate from the 55-gallon drums. Ultrasonic dispersion was achieved using an *Ace Glass* ultrasonic processor Model GE 600 (20 kHz) at 100 percent of the total power (600 watts) for a period of five minutes.

Four-litre transparent polymethylpentene cylinders were used as the bench scale settling columns. Wood stoppers were cut, laminated, and placed in the opening at the top of the cylinders to close the system and prevent contamination. An orifice in the center of each wood stopper allowed for the insertion of a 1/4-inch outside diameter (OD) glass tube into the cylinder for sampling. Attached to the tube outside the cylinder were 1/4-inch ID silicon tubing and a *Cole-Palmer Masterflex* peristaltic pump Model 75553-70 for sample collection. Pump settings corresponded to a 100 mL/minute flow.

The turbidity was measured primarily using a *Hach* turbidimeter Model 2100N in addition to a *HF Scientific* turbidimeter Model DRT-100, both calibrated with a 0.02-200 NTU reference standards.

Chemicals

Calcium chloride-dihydrate ($CaCl_2 \bullet 2H_2O$), magnesium sulfate ($MgSO_4$), sodium chloride (NaCl), and sodium sulfate (Na_2SO_4) salts, obtained from Mallinchkrodt, J. T. Baker, GFS Chemicals, and Aldrich Companies respectively, were used in the study. The salts were dissolved in DDI water.

Methods

Table 5 contains brief descriptions of the analytical methods used in this study, including references for the analytical methods, instrumentation, and detection limits. The majority of the water-quality chemical analyses were performed by the ECB. These included ionic composition, hardness, and alkalinity.

Table 5. Analysis Methods and Instrumentation Descriptions

Parameter	Method	Instrumentation	Detection Limit (mg/L)
Ca^{+2}	EPA SW-846-Method 6010A	Inductively Coupled Plasma (ICP) Emission Spectroscopy	0.1
Mg^{+2}	EPA SW-846-Method 6010A	Inductively Coupled Plasma (ICP) Emission Spectroscopy	0.2
K^+	EPA SW-846-Method 6010A	Inductively Coupled Plasma (ICP) Emission Spectroscopy	1.0
Na^+	EPA SW-846-Method 6010A	Inductively Coupled Plasma (ICP) Emission Spectroscopy	0.1
Alkalinity[*]	Lachat Method No. 10-303-31-1-A	Lachat 8000 Flow Injection Analyzer	0.010-0.500
SO_4^{-2}	EPA SW-846-Method 9056	Dionex Ion Chromatograph DX100	0.375
Cl^-	EPA SW-846-Method 9056	Dionex Ion Chromatograph DX100	0.375
Hardness	Standard Methods Handbook 2340B	Calculation through Ca^{+2} and Mg^{+2} Ions (obtained by ICP)	N/A[**]
TDS	Standard Methods Handbook 2540C	Filtration and Conventional Oven Dried at 180 C	N/A[**]

[*] Reported as mg/L of $CaCO_3$
[**] N/A: Not applicable

5 - Results and Discussion

Results

Turbidity Decay Rate Coefficients

The turbidity data generated during the study are summarized in Tables A1 through A12 (Appendix A). The data exhibited a first order turbidity decay or sedimentation rate in accordance with Equation 1. A linear regression analysis for the log transformation of Equation 1 was performed on data from each replicate to calculate the decay rate for each replicate. The rates are tabulated in Appendix B.

Table 6 summarizes the decay rates for the average of the replicate turbidity data at each TDS concentration studied. The decay coefficients are plotted as a function of the TDS concentration in Figure 3. The decay rate increases gradually from a TDS of 600 mg/L to a TDS of 1857 mg/L but increases more rapidly between a TDS of 1857 mg/L and a TDS of 2900 mg/L for all three levels of initial turbidity. The decay rate at any given TDS concentration increases with the initial turbidity of the sample. The significance of these increases with TDS and initial turbidity was statistically analyzed using ANOVA and means testing presented in Appendix C and discussed below. A linear regression on the coefficients for each specific target TDS concentration and initial turbidity level was performed, which resulted in a mean coefficient and empirically derived equations for each of the turbidity condition (Figure 3).

Table 6. Turbidity Decay Rate Constants

TDS, mg/L	Turbidity Decay Rate (k), 1/hr, as a Function of Initial Turbidity Level		
	Low (8 NTU)	High (24 NTU)	Very High (43 NTU)
600	0.00564	0.00838	0.01211
750	0.00624	0.01041	0.01262
900	0.00783	0.01008	0.01425
1050	0.00700	0.01182	0.01384
1320	0.00819	0.00973	0.01515
1592	0.00801	0.01297	0.01717
1857	0.00938	0.01307	0.01976
2900	0.01607	0.02089	0.06437
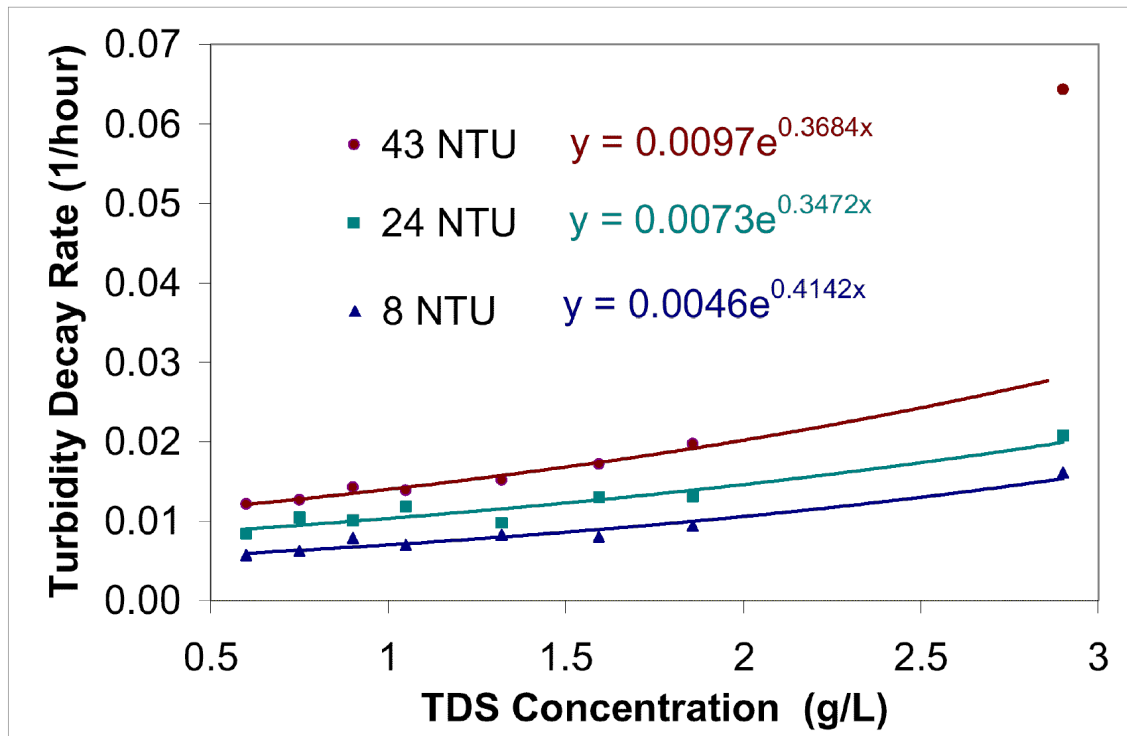
Figure 3. Relationships between turbidity decay rates and TDS concentrations.

Final Turbidity

The means of the replicate turbidity values following 7 days of sedimentation are given in Table 7. Individual replicate data are given in Appendix A.

Statistical Analyses

Turbidity Decay Rate (k)

Variance. A two-way ANOVA with replication was performed to determine how much of the variance in the turbidity decay rate population was attributable to differences in the TDS concentration, initial turbidity, and replication (error). The results show that the differences in the TDS concentration accounted for more than 56 percent of variance, while initial turbidity accounted for about 14 percent of the variance. Covariance between TDS and initial turbidity contributed about 30 percent, and errors contributed to less than 0.1 percent of the variance.

Table 7. Turbidity Results Following 7 Days of Sedimentation

TDS, mg/L	Final (7-day) Turbidity, NTU, as a Function of Initial Turbidity Level		
	Low (8 NTU)	High (24 NTU)	Very High (43 NTU)
600	3.2	5.8	8.1
750	2.7	4.9	7.6
900	2.3	4.6	6.4
1050	2.4	3.8	6.4
1320	2.3	5.4	5.4
1592	2.2	3.5	4.3
1857	1.7	2.9	3.8
2900	1.0	1.2	1.0

Considering the number of levels of TDS and initial turbidity tested, the significance of the effects of TDS and initial turbidity is similar. Therefore, differences in the TDS concentration cause differences in turbidity decay rate with greater than a 99.99 percent probability. The significance of the effects of TDS independent of initial turbidity was verified by performing one-way ANOVA tests on the data at each initial turbidity level separately. The one-way ANOVA yielded the same result. Differences in the initial turbidity cause differences in the turbidity decay rate with greater than a 99.99 percent probability. Finally, the covariance or interaction between TDS and initial turbidity causes differences in the turbidity decay rate with greater than a 99.99 percent probability. Changes in turbidity decay rates were disproportionately larger than average for changes in either TDS or initial turbidity when both the TDS and initial turbidity were large. Analogously, changes in turbidity decay rates were disproportionately smaller than average for changes in either TDS or initial turbidity when both the TDS and initial turbidity were small.

Mean. Comparisons of the mean turbidity decay rates among the various TDS levels using the Duncan's multiple range test without consideration of differences in the initial turbidity show that the mean turbidity decay rate at a TDS of 2900 mg/L was significantly different from any of the mean turbidity decay rates at other TDS concentrations with at least 95 percent probability. Comparisons between results at any lower TDS concentration show that the differences are not significant at a 95 percent confidence level. This result is caused by the effect of initial turbidity. At the lower TDS concentrations, the effect of initial turbidity on decay rates is greater than the effect of TDS. The results of the comparisons are shown in Table 8.

**Table 8. Comparisons of Average Turbidity Decay Rates
Without Consideration of Initial Turbidity**

Comparison		Significance of Difference*	Comparison		Significance of Difference*
TDS Group 1	TDS Group 2		TDS Group 1	TDS Group 2	
2900 mg/L	1857 mg/L	>95%	1592 mg/L	1320 mg/L	NS
2900 mg/L	1592 mg/L	>99%	1592 mg/L	1050 mg/L	NS
2900 mg/L	1320 mg/L	>99%	1592 mg/L	900 mg/L	NS
2900 mg/L	1050 mg/L	>99%	1592 mg/L	750 mg/L	NS
2900 mg/L	900 mg/L	>99%	1592 mg/L	600 mg/L	NS
2900 mg/L	750 mg/L	>99%	1320 mg/L	1050 mg/L	NS
2900 mg/L	600 mg/L	>99%	1320 mg/L	900 mg/L	NS
			1320 mg/L	750 mg/L	NS
1857 mg/L	1592 mg/L	NS	1320 mg/L	600 mg/L	NS
1857 mg/L	1320 mg/L	NS	1050 mg/L	900 mg/L	NS
1857 mg/L	1050 mg/L	NS	1050 mg/L	750 mg/L	NS
1857 mg/L	900 mg/L	NS	1050 mg/L	600 mg/L	NS
1857 mg/L	750 mg/L	NS	900 mg/L	750 mg/L	NS
1857 mg/L	600 mg/L	NS	900 mg/L	600 mg/L	NS
			750 mg/L	600 mg/L	NS

 * NS = not significantly different at 95% probability

Comparisons of the mean turbidity decay rates among the various TDS levels while considering differences in the initial turbidity were made using Duncan's multiple range test and Student's t-test. The results are given in Table 9. The results show that the mean turbidity decay rate at a TDS of 2900 mg/L was significantly different from any of the mean turbidity decay rates at other TDS concentrations with a 99 percent confidence level at both low and high initial turbidity. Comparisons of the mean turbidity decay rate at a TDS of 1857 mg/L with the decay rates at lower TDS concentrations show significant differences at TDS concentrations of 900 mg/L, 750 mg/L and 600 mg/L for both low and high initial turbidity. Differences were also significant at TDS concentrations of 1592 mg/L, 1320 mg/L and 1050 mg/L, but the results were inconsistent between the low and high initial turbidity levels. The effect of TDS is more easily seen at lower TDS concentrations and at lower initial turbidity as shown in Table 9 because there is less variability in the replicates.

Final Turbidity

Variance. A two-way ANOVA with replication was performed to determine how much of the variance in the final (7-day) turbidity population was attributable to differences in the TDS concentration, initial turbidity, and replication (error). The results show that the differences in the TDS concentration accounted for 50 percent of variance, while initial turbidity accounted for about 36 percent of the variance. Covariance between TDS and initial turbidity contributed about 13 percent and errors less than 0.1 percent of the variance.

Considering the number of levels of TDS and initial turbidity tested, the significance of the effects of TDS and initial turbidity are similar though the effect of initial turbidity may be somewhat greater. Differences in the TDS concentration cause differences in final turbidity with greater than a 99.99 percent probability. The significance of the effects of TDS independent of initial turbidity was verified by performing one-way ANOVA tests on the data at each initial turbidity level separately. The one-way ANOVA yielded the same result. Differences in the initial turbidity cause differences in the final turbidity with greater than a 99.99 percent probability. Finally, the covariance or interaction between TDS and initial turbidity causes differences in the final turbidity with greater than a 99.99 percent probability. Changes in final turbidity were disproportionately larger than average for changes in either TDS or initial turbidity when both the TDS and initial turbidity were small. Analogously, changes in final turbidity were disproportionately smaller than average for changes in either TDS or initial turbidity when both the TDS and initial turbidity were large.

Mean. Comparisons of the mean final turbidity among the various TDS levels using the Duncan's multiple range test without consideration of differences in the initial turbidity show that the mean final turbidity at a TDS of 2900 mg/L was significantly different from any of the mean turbidity decay rates at any other TDS concentrations with at least 95 percent probability. Differences in the final turbidity between samples having a TDS concentration more than 980 mg/L were significant with a minimum of 95 percent confidence. Differences in the final turbidity between samples having a TDS concentration less than 980 mg/L were not significant with a minimum of 95 percent confidence. Differences in the initial turbidity can mask the effects of changes in TDS smaller than 980 mg/L. The results of the comparisons are shown in Table 10.

Table 9. Comparisons of Turbidity Decay Rates

Comparisons at Low Initial Turbidity		Significance of Difference*	Comparisons at High Initial Turbidity		Significance of Difference*
TDS Group 1	TDS Group 2		TDS Group 1	TDS Group 2	
2900 mg/L	1857 mg/L	>99%	2900 mg/L	1857 mg/L	>99%
2900 mg/L	1592 mg/L	>99%	2900 mg/L	1592 mg/L	>99%
2900 mg/L	1320 mg/L	>99%	2900 mg/L	1320 mg/L	>99%
2900 mg/L	1050 mg/L	>99%	2900 mg/L	1050 mg/L	>99%
2900 mg/L	900 mg/L	>99%	2900 mg/L	900 mg/L	>99%
2900 mg/L	750 mg/L	>99%	2900 mg/L	750 mg/L	>99%
2900 mg/L	600 mg/L	>99%	2900 mg/L	600 mg/L	>99%
1857 mg/L	1592 mg/L	>95%	1857 mg/L	1592 mg/L	NS
1857 mg/L	1320 mg/L	NS	1857 mg/L	1320 mg/L	>99%
1857 mg/L	1050 mg/L	>99%	1857 mg/L	1050 mg/L	NS
1857 mg/L	900 mg/L	>95%	1857 mg/L	900 mg/L	>99%
1857 mg/L	750 mg/L	>99%	1857 mg/L	750 mg/L	>99%
1857 mg/L	600 mg/L	>99%	1857 mg/L	600 mg/L	>99%
1592 mg/L	1320 mg/L	NS	1592 mg/L	1320 mg/L	>99%
1592 mg/L	1050 mg/L	NS	1592 mg/L	1050 mg/L	NS
1592 mg/L	900 mg/L	NS	1592 mg/L	900 mg/L	>99%
1592 mg/L	750 mg/L	>95%	1592 mg/L	750 mg/L	>99%
1592 mg/L	600 mg/L	>99%	1592 mg/L	600 mg/L	>99%
1320 mg/L	1050 mg/L	NS	1320 mg/L	1050 mg/L	>95%
1320 mg/L	900 mg/L	NS	1320 mg/L	900 mg/L	NS
1320 mg/L	750 mg/L	>99%	1320 mg/L	750 mg/L	NS
1320 mg/L	600 mg/L	>99%	1320 mg/L	600 mg/L	NS
1050 mg/L	900 mg/L	NS	1050 mg/L	900 mg/L	>95%
1050 mg/L	750 mg/L	NS	1050 mg/L	750 mg/L	NS
1050 mg/L	600 mg/L	>95%	1050 mg/L	600 mg/L	>99%
900 mg/L	750 mg/L	>95%	900 mg/L	750 mg/L	NS
900 mg/L	600 mg/L	>99%	900 mg/L	600 mg/L	>95%
750 mg/L	600 mg/L	NS	750 mg/L	600 mg/L	>95%

* NS = not significantly different at 95% probability

**Table 10. Comparisons of Average Final Turbidity
Without Consideration of Initial Turbidity**

Comparison		Significance of Difference*	Comparison		Significance of Difference*
TDS Group 1	TDS Group 2		TDS Group 1	TDS Group 2	
2900 mg/L	1857 mg/L	>95%	1592 mg/L	1320 mg/L	NS
2900 mg/L	1592 mg/L	>95%	1592 mg/L	1050 mg/L	NS
2900 mg/L	1320 mg/L	>99%	1592 mg/L	900 mg/L	NS
2900 mg/L	1050 mg/L	>99%	1592 mg/L	750 mg/L	NS
2900 mg/L	900 mg/L	>99%	1592 mg/L	600 mg/L	>95%
2900 mg/L	750 mg/L	>99%	1320 mg/L	1050 mg/L	NS
2900 mg/L	600 mg/L	>99%	1320 mg/L	900 mg/L	NS
			1320 mg/L	750 mg/L	NS
1857 mg/L	1592 mg/L	NS	1320 mg/L	600 mg/L	NS
1857 mg/L	1320 mg/L	NS	1050 mg/L	900 mg/L	NS
1857 mg/L	1050 mg/L	NS	1050 mg/L	750 mg/L	NS
1857 mg/L	900 mg/L	NS	1050 mg/L	600 mg/L	NS
1857 mg/L	750 mg/L	>95%	900 mg/L	750 mg/L	NS
1857 mg/L	600 mg/L	>99%	900 mg/L	600 mg/L	NS
			750 mg/L	600 mg/L	NS

 * NS = not significantly different at 95% probability

Comparisons of the mean final turbidity among the various TDS levels while considering differences in the initial turbidity were made using Duncan's multiple range test and Student's t-test. The results are given in Table 11. The results show that the mean final turbidity at a TDS of 2900 mg/L was significantly different from any of the mean final turbidity at other TDS concentrations with a 99 percent confidence level for both low and high initial turbidity. Comparisons of the mean final turbidity at a TDS of 1857 mg/L with the final turbidity at any other TDS concentrations show significant differences at greater than a 95 percent confidence level. Generally, the final turbidity at 600 mg/L TDS and at 750 mg/L TDS were also significantly different from the final turbidity at all other TDS concentrations. The results at 1592 mg/L, 1320 mg/L, 1050 mg/L, and 900 mg/L TDS were inconsistent, sporadically showing significant differences at low or high initial turbidity. The effect of TDS is more easily seen at lower TDS concentrations where there is less variability in the replicates and at high TDS concentrations where the turbidity decay rates are greater to produce greater changes in turbidity.

Table 11. Comparisons of Final (7-day) Turbidities

Comparisons at Low Initial Turbidity		Significance of Difference*	Comparisons at High Initial Turbidity		Significance of Difference*
TDS Group 1	TDS Group 2		TDS Group 1	TDS Group 2	
2900 mg/L	1857 mg/L	>99%	2900 mg/L	1857 mg/L	>99%
2900 mg/L	1592 mg/L	>99%	2900 mg/L	1592 mg/L	>99%
2900 mg/L	1320 mg/L	>99%	2900 mg/L	1320 mg/L	>99%
2900 mg/L	1050 mg/L	>99%	2900 mg/L	1050 mg/L	>99%
2900 mg/L	900 mg/L	>99%	2900 mg/L	900 mg/L	>99%
2900 mg/L	750 mg/L	>99%	2900 mg/L	750 mg/L	>99%
2900 mg/L	600 mg/L	>99%	2900 mg/L	600 mg/L	>99%
1857 mg/L	1592 mg/L	>99%	1857 mg/L	1592 mg/L	>95%
1857 mg/L	1320 mg/L	>99%	1857 mg/L	1320 mg/L	>99%
1857 mg/L	1050 mg/L	>99%	1857 mg/L	1050 mg/L	>99%
1857 mg/L	900 mg/L	>99%	1857 mg/L	900 mg/L	>99%
1857 mg/L	750 mg/L	>99%	1857 mg/L	750 mg/L	>99%
1857 mg/L	600 mg/L	>99%	1857 mg/L	600 mg/L	>99%
1592 mg/L	1320 mg/L	NS	1592 mg/L	1320 mg/L	>99%
1592 mg/L	1050 mg/L	NS	1592 mg/L	1050 mg/L	NS
1592 mg/L	900 mg/L	NS	1592 mg/L	900 mg/L	>99%
1592 mg/L	750 mg/L	>99%	1592 mg/L	750 mg/L	>99%
1592 mg/L	600 mg/L	>99%	1592 mg/L	600 mg/L	>99%
1320 mg/L	1050 mg/L	NS	1320 mg/L	1050 mg/L	>99%
1320 mg/L	900 mg/L	NS	1320 mg/L	900 mg/L	>95%
1320 mg/L	750 mg/L	>99%	1320 mg/L	750 mg/L	NS
1320 mg/L	600 mg/L	>99%	1320 mg/L	600 mg/L	NS
1050 mg/L	900 mg/L	NS	1050 mg/L	900 mg/L	>95%
1050 mg/L	750 mg/L	>99%	1050 mg/L	750 mg/L	>99%
1050 mg/L	600 mg/L	>99%	1050 mg/L	600 mg/L	>99%
900 mg/L	750 mg/L	>99%	900 mg/L	750 mg/L	NS
900 mg/L	600 mg/L	>99%	900 mg/L	600 mg/L	>99%
750 mg/L	600 mg/L	>99%	750 mg/L	600 mg/L	>95%

* NS = not significantly different at 95% probability

Comparison of Pre- and Post-Project Conditions

The change in turbidity due to implementation of the chloride reduction project following a disturbance (inflow of suspended solids, overturning, or erosion) in Lake Kemp is a function of the TDS concentration present, the size of the disturbance (initial turbidity), and the elapsed time since the disturbance. To compare pre- and post-project conditions, it is necessary to compare the effects of changes in turbidity decay rates at various frequencies of occurrences. The pre- and post-project concentration-duration levels are given in Table 1. The lab conditions were set at projected levels which would be exceeded approximately 1, 20, 50, and 85% of the time following construction of the project. Regression equations were developed to predict turbidity decay rates as a function of TDS concentration for low, high and very high initial turbidity. The regression equations are shown in Figure 3 along the laboratory derived decay rates. Representative pre-project and post-project turbidity decay rates computed from the regression equations for TDS concentrations predicted to be exceeded 1, 10, 20, 50, 80, 90 and 99% of the time (given in Table 1) are listed in Table 12.

Table 12. Pre- and Post-Project Turbidity Decay Rates

Frequency Concentration Exceeded (percent)	Computed Pre- and Post-Project Turbidity Decay Rates (k), 1/hr, as a Function of Initial Turbidity Level					
	Low (8 NTU)		High (24 NTU)		Very High (43 NTU)	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
1	0.01340	0.00795	0.01802	0.01159	0.02522	0.01582
5	0.01279	0.00755	0.01732	0.01110	0.02419	0.01511
10	0.01241	0.00741	0.01688	0.01092	0.02354	0.01486
20	0.01117	0.00716	0.01545	0.01062	0.02143	0.01441
50	0.00995	0.00667	0.01401	0.00999	0.01933	0.01352
80	0.00888	0.00596	0.01273	0.00908	0.01747	0.01222
90	0.00842	0.00579	0.01217	0.00887	0.01666	0.01191
95	0.00826	0.00568	0.01197	0.00873	0.01636	0.01171
99	0.00803	0.00556	0.01169	0.00857	0.01597	0.01150

To compare pre- and post-project conditions, predictions of turbidity versus time are given in Figures 4 through 10 for seven frequencies of occurrence with three initial turbidity levels. Comparison of the curves in these figures yields the maximum differences in turbidity between pre- and post-project conditions following an introduction of turbidity and shows when the maximum difference occurs after the introduction of turbidity. These results are presented in Table 13. Comparison of the curves also shows the persistence of increases in turbidity and average increase in turbidity.

The results in Table 13 show that a disturbance yields a maximum increase in turbidity that is about 15 percent of the size of the disturbance greater than the pre-project response to the disturbance. The maximum increases are about 1.5, 3.0, and 5.6 NTU for initial turbidity levels of 8, 24, and 43 NTU, respectively. The maximum increases are likely to occur about 3 to 4 days after the turbidity generation occurred. The increases in turbidity would be expected to be somewhat persistent; increases of 50% of the maximum above pre-project conditions would be expected to persist one to two weeks. The average 10-day increase over pre-project responses are about 35 percent. As such, surface turbidity may be expected to increase by about 2 to 3 NTU, and bottom turbidity may be expected to increase by about 4 to 8 NTU.

These comparisons are based on laboratory sedimentation rates. Actual rates in the field would be expected to vary somewhat since there is more mixing and dispersion in Lake Kemp that may speed up sedimentation by mixing in more saline water or by providing flocculation, or slow the sedimentation by resuspending the particles and by requiring larger flocs for sedimentation. In addition, the surface turbidity may be influenced by the hydrodynamics of the lake that may cause the inflow to plunge, mix or ride on the surface.
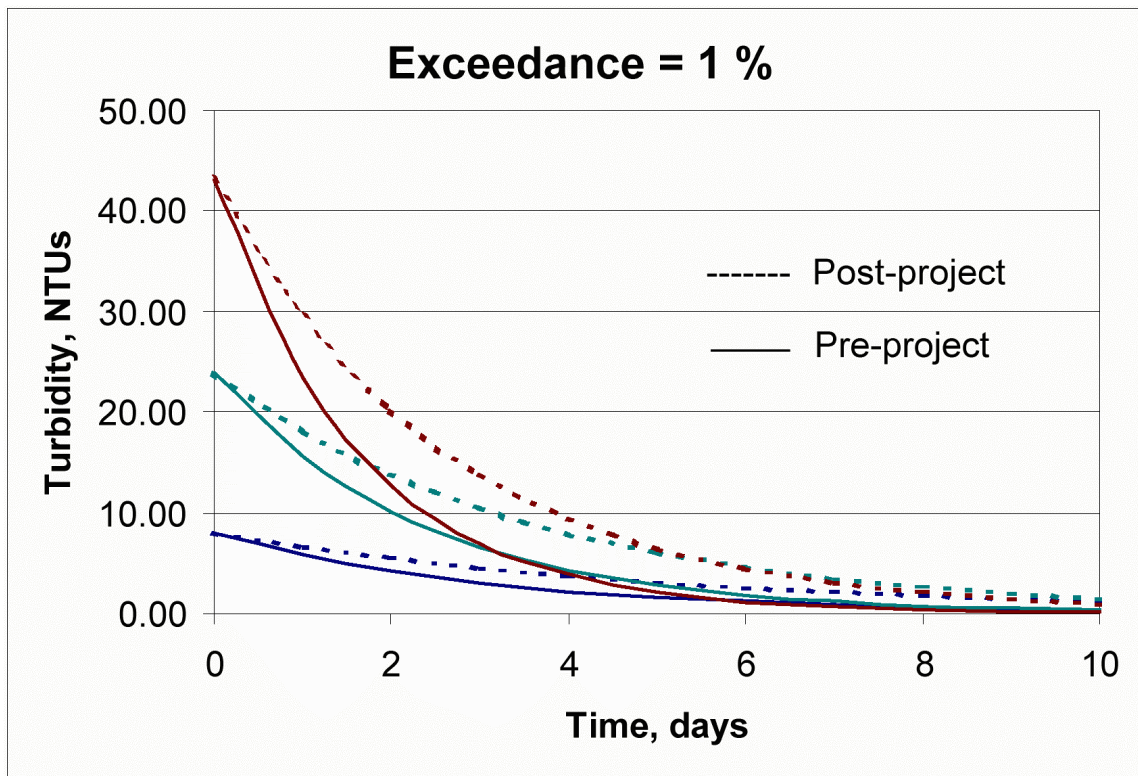

Figure 4. Turbidity response curves for 1% exceedance TDS concentration.

Table 13. Comparisons of Pre- and Post-Project Turbidity

Duration Concentration Exceeded (percent of time)	Average 10-day Increase in Percent of Pre-project Turbidity	Maximum Increase in Turbidity (NTU)	Time When Maximum Increase Occurs (days)	Duration Greater than 50% of Maximum Increase (days)
Low Initial Turbidity (8 NTU)				
1	47.4	1.52	3.9	10
10	45.1	1.50	4.3	11
20	36.7	1.29	4.6	11
50	31.0	1.17	5.0	13
80	29.0	1.17	5.7	14
90	26.3	1.10	5.8	15
99	25.0	1.07	6.0	16
High Initial Turbidity (24 NTU)				
1	42.9	3.86	2.8	7
10	41.8	3.81	3.0	8
20	34.8	3.28	3.2	8
50	30.2	2.94	3.5	9
80	29.3	2.97	3.8	9
90	26.9	2.79	4.0	9
99	25.9	2.73	4.1	10
Very High Initial Turbidity (43 NTU)				
1	45.9	7.31	2.1	5
10	45.5	7.19	2.2	5
20	38.4	6.16	2.3	6
50	34.1	5.55	2.6	6
80	33.7	5.61	2.8	7
90	31.2	5.28	2.9	7
99	30.3	5.17	3.0	7

Figure 5. Turbidity response curves for 10% exceedance TDS concentration.

Figure 6. Turbidity response curves for 20% exceedance TDS concentration.

25

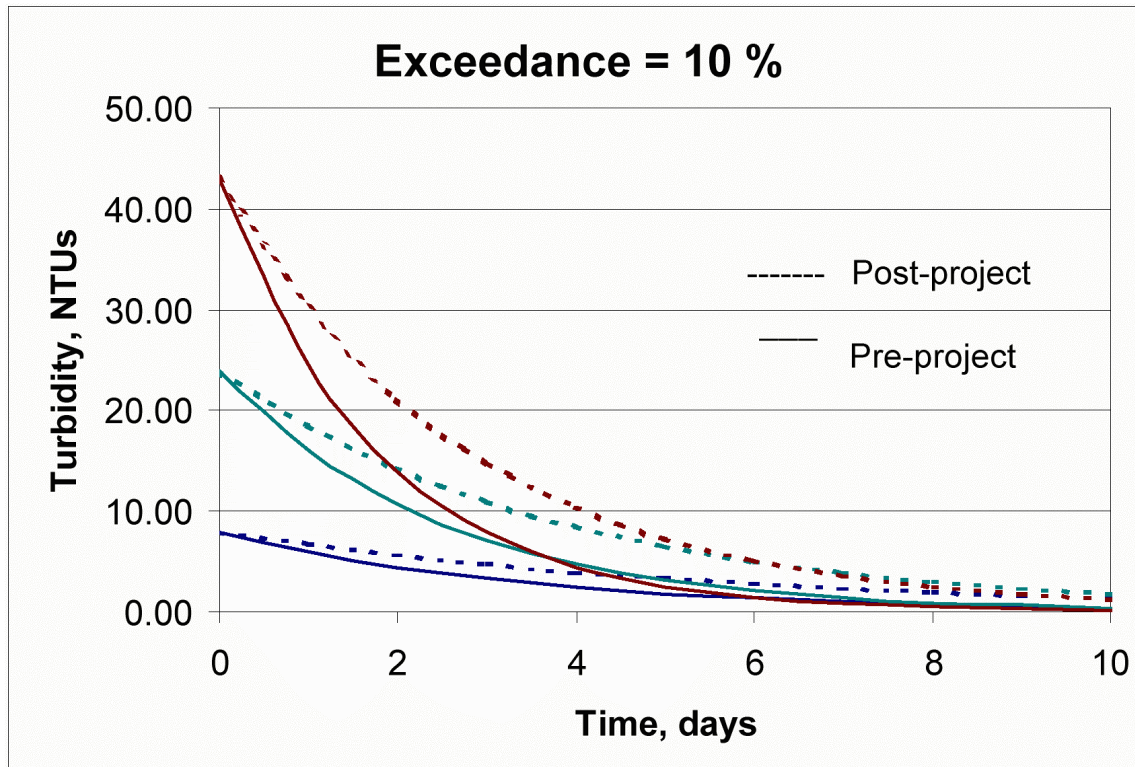**Figure 7**. Turbidity response curves for 50% exceedance TDS concentration.

Figure 8. Turbidity response curves for 80% exceedance TDS concentration.
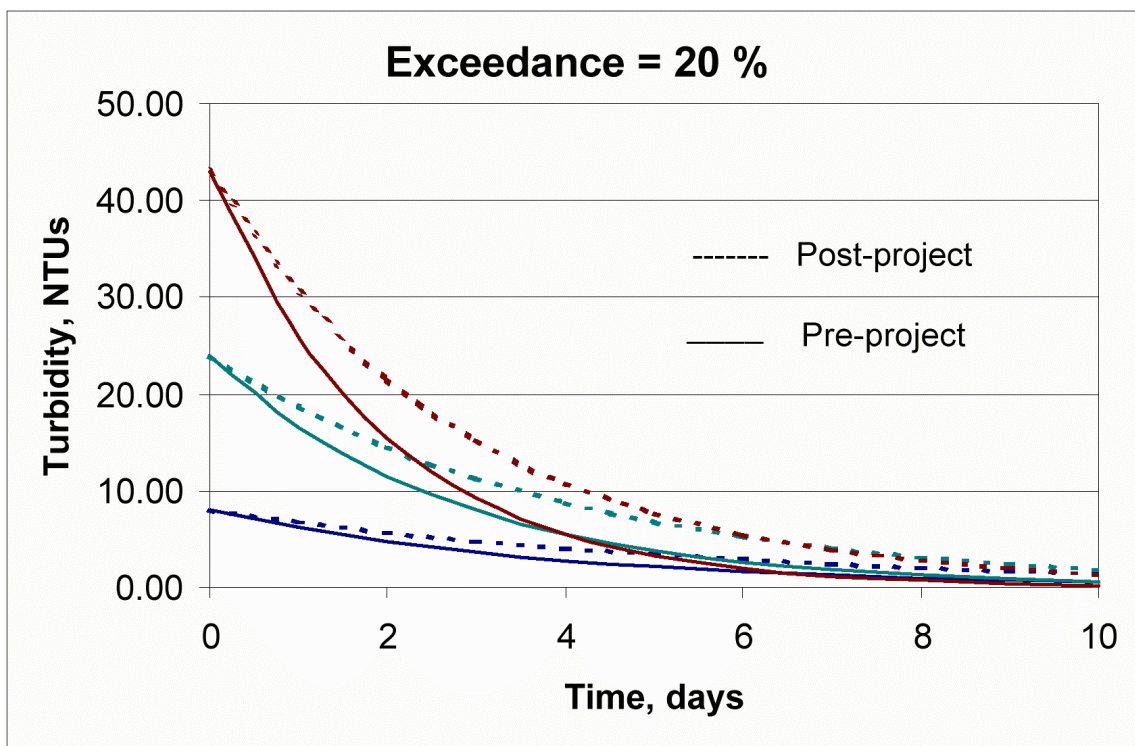
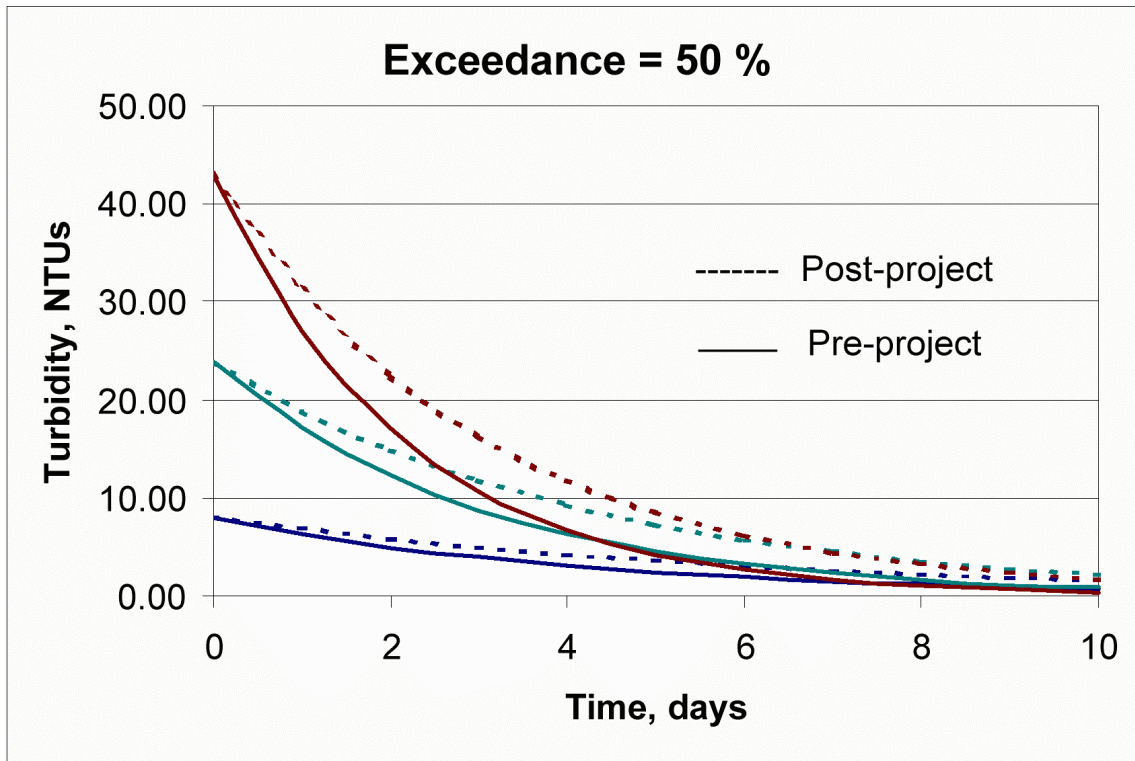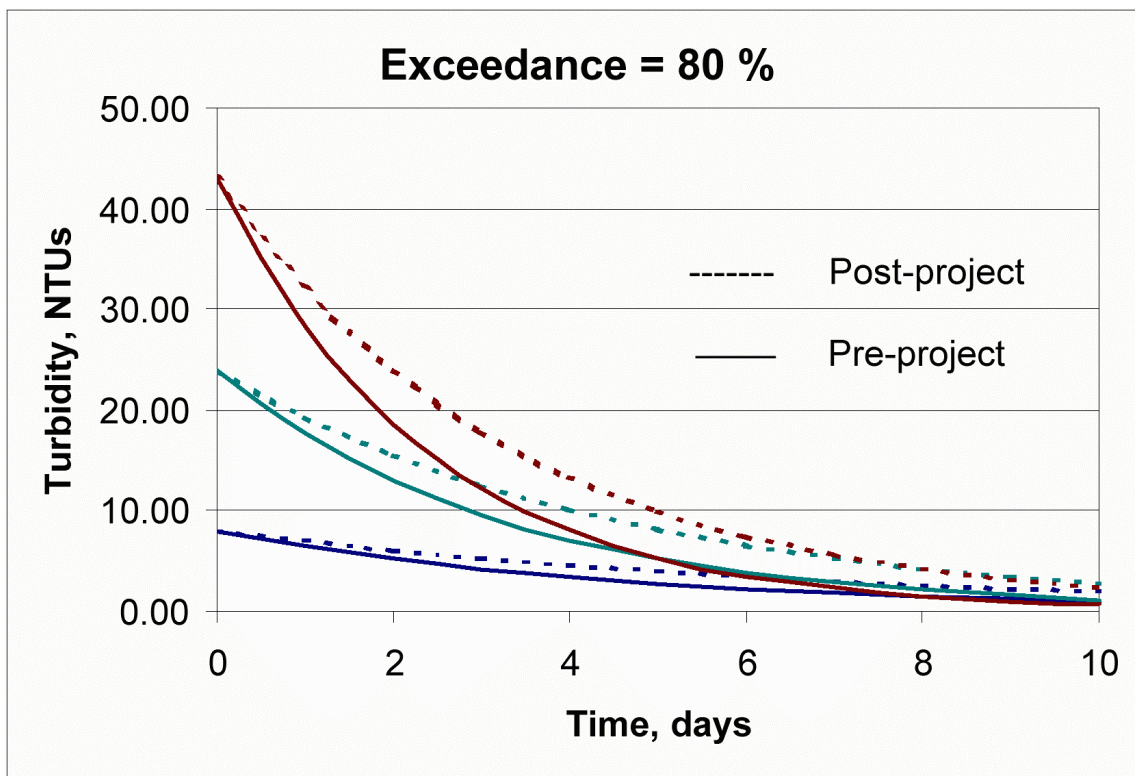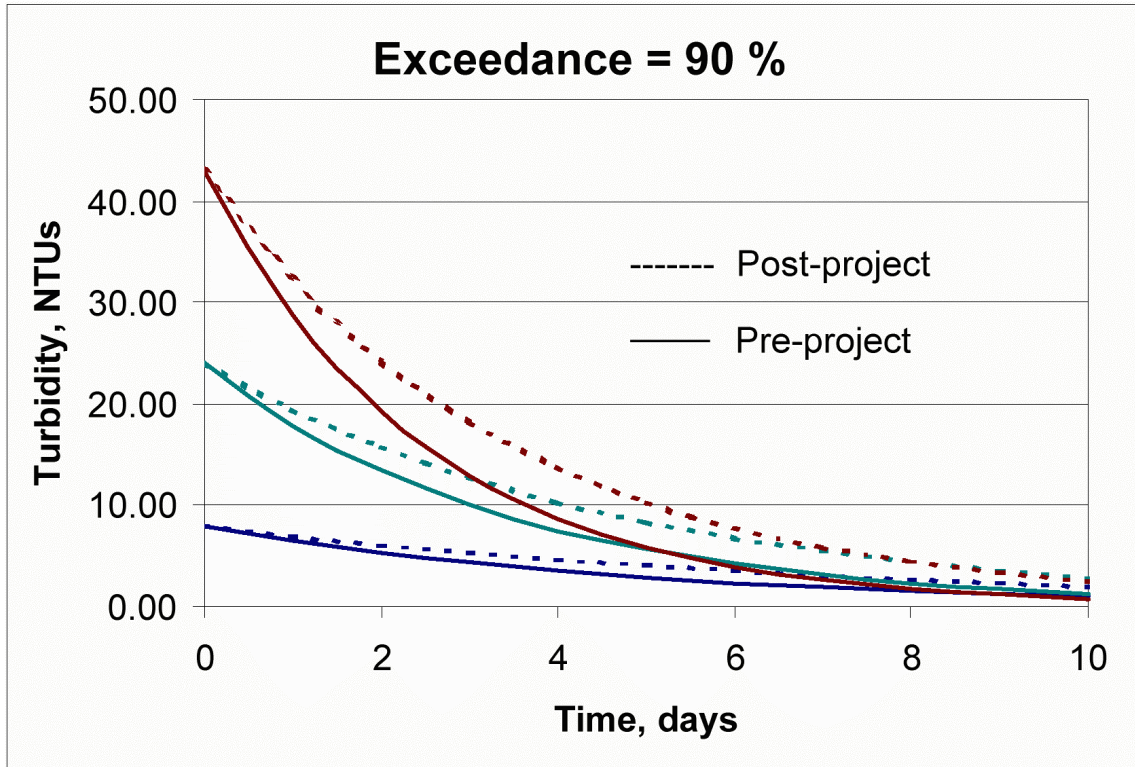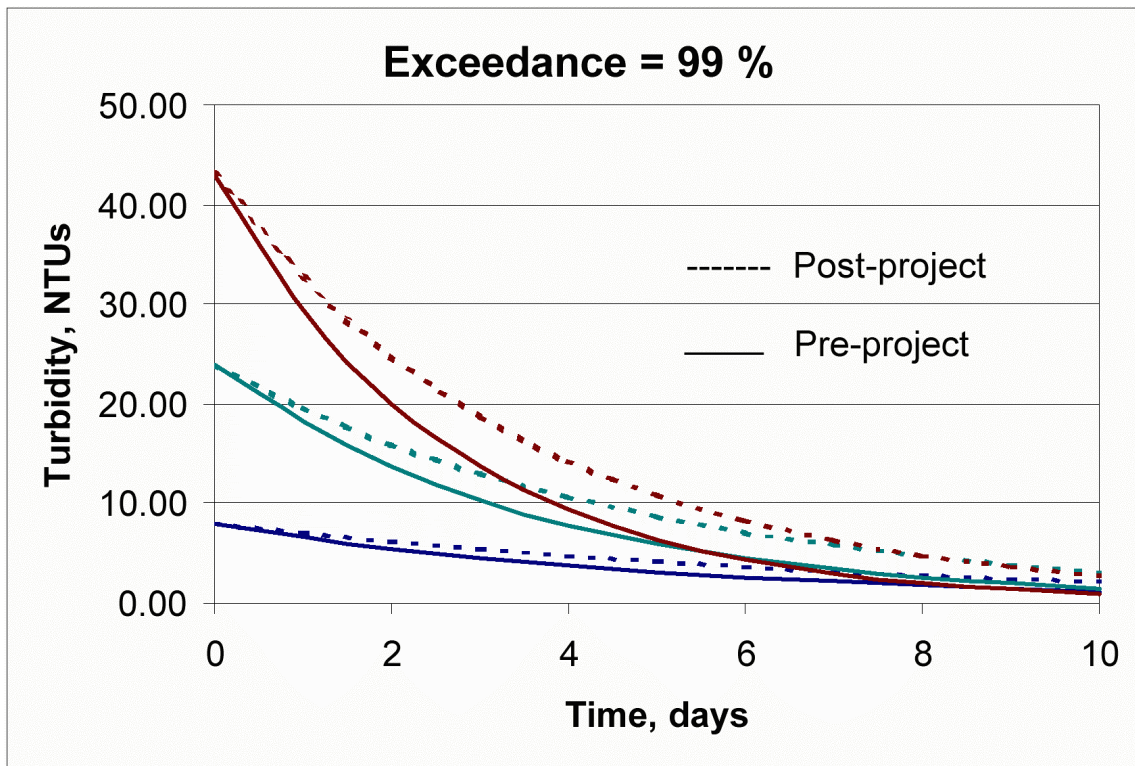**Figure 9**. Turbidity response curves for 90% exceedance TDS concentration.

Figure 10. Turbidity response curves for 99% exceedance TDS concentration.

27

6 - Conclusions

The results of this study demonstrated that:

a. Turbidity decay rates or sedimentation rates are strongly related to the TDS concentration over the entire range (600 mg/L to 2900 mg/L) examined. A reduction in chlorides, and therefore a reduction in TDS, will contribute to a decrease in the sedimentation rate in the Lake Kemp. Over the range of TDS reductions examined the sedimentation or turbidity decay rate generally varied by about a factor of four. This means that the slowest settling test condition in the laboratory would take about four times as long to achieve the same percent removal of turbidity following a disturbance or introduction of turbidity.

b. The post-project turbidity decay rate for a given probability of TDS concentration exceedance and initial turbidity is approximately 60 to 70 percent of the pre-project turbidity decay rate for the same probability of exceedance and initial turbidity. Therefore, the time required to achieve any given percent turbidity removal is about 40 to 70 percent longer, typically less than 50 percent longer.

c. The turbidity decay rates at each of the three initial turbidity levels tested were significantly different from each other. Turbidity decay rates are a strong function of initial turbidity.

d. The final (7-day) turbidity was a strong function of the initial turbidity and the TDS concentration.

e. The maximum increases are about 1.5, 3.0, and 5.6 NTU for initial turbidity levels of 8, 24, and 43 NTU, respectively.

f. The maximum increases are likely to occur about 3 to 4 days after the turbidity generation occurred. Comparison of responses to introduction of turbidity under pre- and post-project conditions showed little difference for 50 percent of the time. Post-project turbidity levels would be less than 1 NTU, generally less than 0.5 NTU, higher than pre-project levels. These elevated levels would last several days and start about two days after the introduction of turbidity based on the laboratory sedimentation rates.

g. The increases in turbidity are expected to be somewhat persistent; increases of 50% of the maximum above pre-project conditions are expected to persist one to two weeks. The average 10-day increase over pre-project responses are about 35 percent. As such, surface turbidity may be expected to increase by about 2 to 3 NTU and bottom turbidity may be expected to increase by about 4 to 8 NTU.

7 - References

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Appendix A - Turbidity Data Tables

TDS =   600 mg/L

Time, hrs	Turbidity (NTU)					
	Initial Turbidity 43 NTU	Initial Turbidity 24 NTU		Initial Turbidity 8 NTU		
		Replicate 1*	Replicate 2*	Replicate 1*	Replicate 2*	Replicate 3*
0	44.20	22.54	22.54	8.10	8.03	7.89
1.5		21.13	21.13	8.17	7.71	7.54
3	40.55	20.97	20.77	7.96	7.52	7.36
7	39.95	19.72	19.72	7.24	7.00	7.11
13	38.30	19.12	19.01	7.54	6.93	6.98
24	30.90	17.01	17.31	7.08	6.59	6.44
36		15.79	16.08	6.56	6.29	6.04
48	21.15	14.56	13.98	6.02	6.00	5.52
72	16.75	11.64	11.00	5.11	5.00	4.83
96	13.35	9.50	9.36	4.46	4.56	4.30
120	10.95	7.91	7.99	4.04	4.09	3.66
144	9.25	6.84	6.37	3.55	3.59	3.29
168	8.10	5.89	5.74	3.26	3.36	2.99

* Values for high (24 NTU) and low (8 NTU) initial turbidity were calibrated from HF turbidimeter values
  to Hach turbidimeter values based on turbidity decay rates

TDS =   **750 mg/L**

Time, hrs	Turbidity (NTU)					
	Initial Turbidity 43 NTU	Initial Turbidity 24 NTU		Initial Turbidity 8 NTU		
		Replicate 1	Replicate 2	Replicate 1	Replicate 2	Replicate 3
0	42.55	23.60	25.00	8.05	8.05	7.90
3	38.40	20.00	21.55	7.80	7.20	7.00
6	38.10	20.05	22.15	8.30	7.25	7.10
12	36.20	19.20	21.10	8.30	7.25	7.15
24	27.00	17.35	18.50	7.60	6.60	6.50
48	20.10	12.75	12.75	6.25	5.80	5.55
72	15.60	10.50	10.55	5.30	5.15	4.95
96	11.80	8.00	8.35	4.50	4.55	4.40
120	10.00	6.20	6.50	3.60	3.55	3.60
144	8.65	5.50	5.80	3.15	3.30	3.00
168	7.65	4.80	5.00	2.70	2.80	2.60

TDS =   900 mg/L

Time, hrs	Turbidity (NTU)					
	Initial Turbidity 43 NTU	Initial Turbidity 24 NTU		Initial Turbidity 8 NTU		
		Replicate 1	Replicate 2	Replicate 1	Replicate 2	Replicate 3
0	42.60	23.20	23.10	8.30	8.00	7.95
1.5		19.80	20.85	8.45	7.45	7.45
3	38.70	20.00	20.20	8.05	7.60	7.85
7	36.80	19.60	20.00	8.10	7.25	7.45
12	35.70	19.10	19.30	7.90	7.15	7.15
24	25.10	17.50	17.60	7.30	6.80	6.65
48	18.40	12.65	12.40	5.90	5.35	5.20
72	13.70	10.15	10.10	4.65	4.50	4.50
96	10.80	7.90	7.60	3.80	3.50	3.50
120	8.55	6.60	6.30	3.20	2.95	3.10
144	7.75	5.55	5.45	2.70	2.60	2.65
168	6.45	4.65	4.60	2.20	2.30	2.40

TDS =   **1050 mg/L**

Time, hrs	Turbidity (NTU)					
	Initial Turbidity 43 NTU	Initial Turbidity 24 NTU		Initial Turbidity 8 NTU		
		Replicate 1	Replicate 2	Replicate 1	Replicate 2	Replicate 3
0	40.50	23.10	23.10	8.20	7.90	7.65
3	37.05	19.95	19.90	7.90	7.25	7.20
6	35.90	20.65	19.55	7.35	6.90	6.90
12	34.70	19.60	18.90	7.90	6.70	6.70
24	26.20	17.40	17.20	7.35	6.75	6.40
48	18.70	12.90	12.30	5.90	5.30	5.20
72	13.55	9.40	8.70	4.80	4.65	4.55
96	10.20	6.45	6.20	3.90	3.90	3.90
120	8.35	4.95	4.80	3.30	3.10	3.20
144	7.00	4.70	4.60	2.90	3.00	2.90
168	6.35	3.80	3.70	2.30	2.40	2.35

TDS = 1320 mg/L

Time, hrs	Turbidity (NTU)					
	Initial Turbidity 43 NTU	Initial Turbidity 24 NTU		Initial Turbidity 8 NTU		
		Replicate 1	Replicate 2	Replicate 1	Replicate 2	Replicate 3
0	43.45	23.20	24.15	8.10	8.25	7.90
1.5		21.85	23.15	8.20	7.90	7.50
3	39.45	20.25	20.95	8.30	7.70	7.15
6	38.80	19.85	20.80	8.00	7.70	7.10
12	37.60	19.55	20.75	7.95	7.25	7.05
24	26.80	17.55	18.05	7.30	6.45	6.40
48	19.10	13.95	14.45	5.95	5.50	5.35
72	12.95	10.05	10.55	4.60	4.00	4.05
96	10.10	8.25	8.65	3.90	3.30	3.35
120	8.45	6.70	7.00	3.30	2.70	2.80
144	6.70	5.65	6.00	2.70	2.30	2.40
168	5.35	5.10	5.60	2.40	2.20	2.20

TDS = 1592 mg/L

Time, hrs	Turbidity (NTU)					
	Initial Turbidity 43 NTU	Initial Turbidity 24 NTU		Initial Turbidity 8 NTU		
		Replicate 1	Replicate 2	Replicate 1	Replicate 2	Replicate 3
0	43.35	24.15	25.00	8.25	8.25	8.05
3	37.05	19.85	20.50	7.80	7.35	7.45
6	38.50	19.20	20.30	7.70	6.90	6.95
12	37.20	19.70	20.60	7.95	7.35	7.25
24.3	24.90	17.00	17.80	7.00	6.70	6.50
48	16.80	11.25	12.20	5.95	5.55	5.50
72	11.60	8.30	8.25	4.75	4.50	4.50
96	8.20	5.90	6.00	3.55	3.40	3.30
120	7.20	4.80	5.10	3.00	3.00	2.85
144	5.15	4.05	4.20	2.50	2.50	2.30
168	4.30	3.30	3.60	2.25	2.20	2.20

TDS =   1857 mg/L

Time, hrs	Turbidity (NTU)					
	Initial Turbidity 43 NTU	Initial Turbidity 24 NTU		Initial Turbidity 8 NTU		
		Replicate 1*	Replicate 2*	Replicate 1*	Replicate 2*	Replicate 3*
0	43.50	22.54	21.13	8.10	8.03	7.96
1.5		21.58	20.11	7.68	7.38	7.54
3	38.30	20.72	19.61	7.51	7.69	7.12
6	37.50	19.98	17.90	7.09	7.30	7.08
12	35.60	18.40	16.40	6.40	6.80	6.56
24	21.30	15.44	14.58	5.86	6.20	6.11
37		13.46	12.42	5.22	5.33	5.23
48	14.60	10.79	10.74	4.57	4.89	4.72
72	10.20	7.89	7.98	3.63	3.87	3.67
96	7.70	5.93	6.40	3.01	3.23	2.90
120	6.60	4.27	5.15	2.44	2.66	2.43
144	4.60	3.23	3.95	2.10	2.24	2.00
168	3.75	2.54	2.86	1.97	2.02	1.83

* Values for high (24 NTU) and low (8 NTU) initial turbidity were calibrated from HF turbidimeter values
   to Hach turbidimeter values based on turbidity decay rates

TDS =   2900 mg/L

Time, hrs	Turbidity (NTU)					
	Initial Turbidity 43 NTU	Initial Turbidity 24 NTU		Initial Turbidity 8 NTU		
		Replicate 1	Replicate 2	Replicate 1	Replicate 2	Replicate 3
0	45.80	24.80	25.95	8.35	8.20	8.50
3	37.90	20.00	20.20	7.70	7.50	7.45
6	31.40	19.25	20.15	6.90	7.25	7.25
12	23.15	18.00	19.50	7.15	6.90	7.10
24	7.45	14.00	16.50	6.05	6.00	5.95
48	2.55	8.85	9.05	3.45	3.95	4.20
72	1.50	5.40	3.70	1.60	2.20	2.30
96	1.25	3.40	1.80	1.10	1.50	1.60
120	1.00	2.40	1.55	1.00	1.45	1.50
144	0.88	1.60	1.10	0.90	1.10	1.20
168	1.00	1.30	1.00	0.80	1.00	1.10

Appendix B - Linear Regression Analysis Summary for Turbidity Decay Rate Constants

Contents

TDS 600 Low Turbidity (Replicate 1)

y = a exp(-bx)

r² = 0.9981349   DF Adj r² = 0.99776189   FitStdErr = 0.09063771   Fstat = 5886.8225

a = 8.1820435

b = 0.0066560223
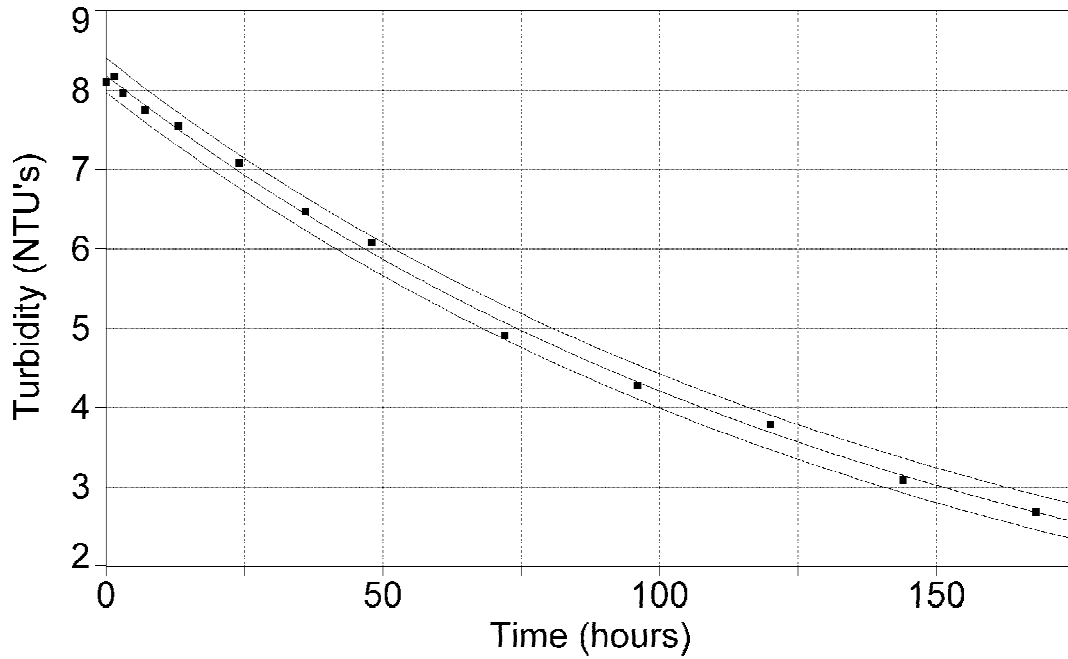
TDS 600 Low Turbidity (Replicate 2)

y = a exp(-bx)

r² = 0.98533671   DF Adj r² = 0.98240405   FitStdErr = 0.20327584   Fstat = 739.17283

a = 7.6094318

b = 0.0052376535

B3
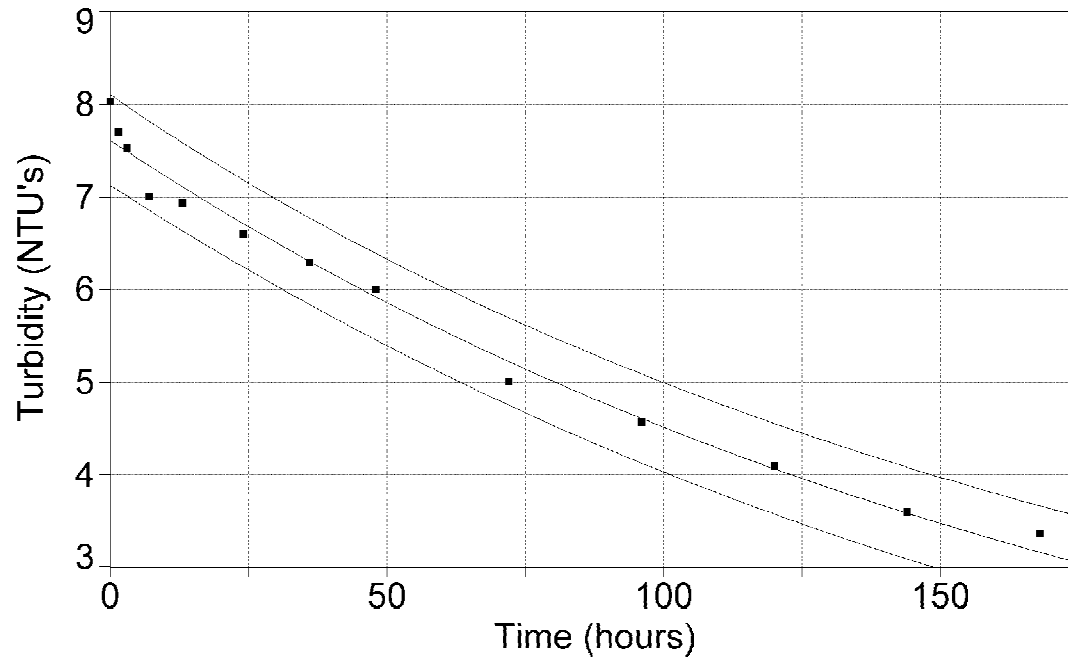
TDS 600 Low Turbidity (Replicate 3)

y = a exp(-bx)

r² = 0.99322586   DF Adj r² = 0.99187103   FitStdErr = 0.14739512   Fstat = 1612.8213

a = 7.5445044

b = 0.0059164675
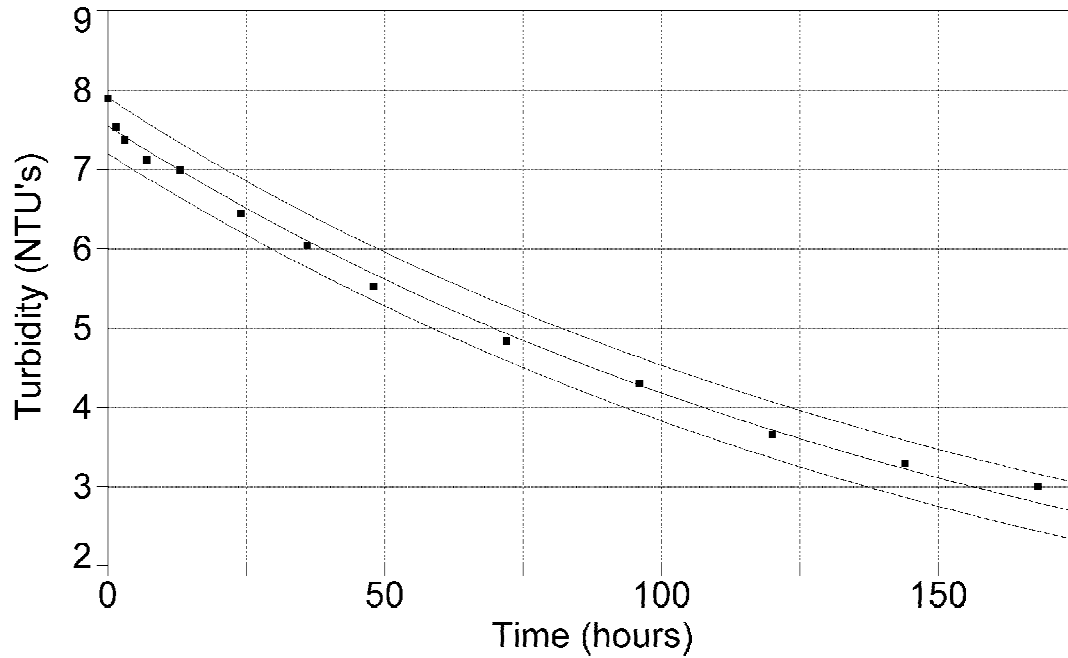
TDS 600 Low Turbidity (Average)

y = a exp(-bx)

r² = 0.99225405   DF Adj r² = 0.99070486   FitStdErr = 0.15666109   Fstat = 1409.0967

a = 7.723417

b = 0.0056327104

B4
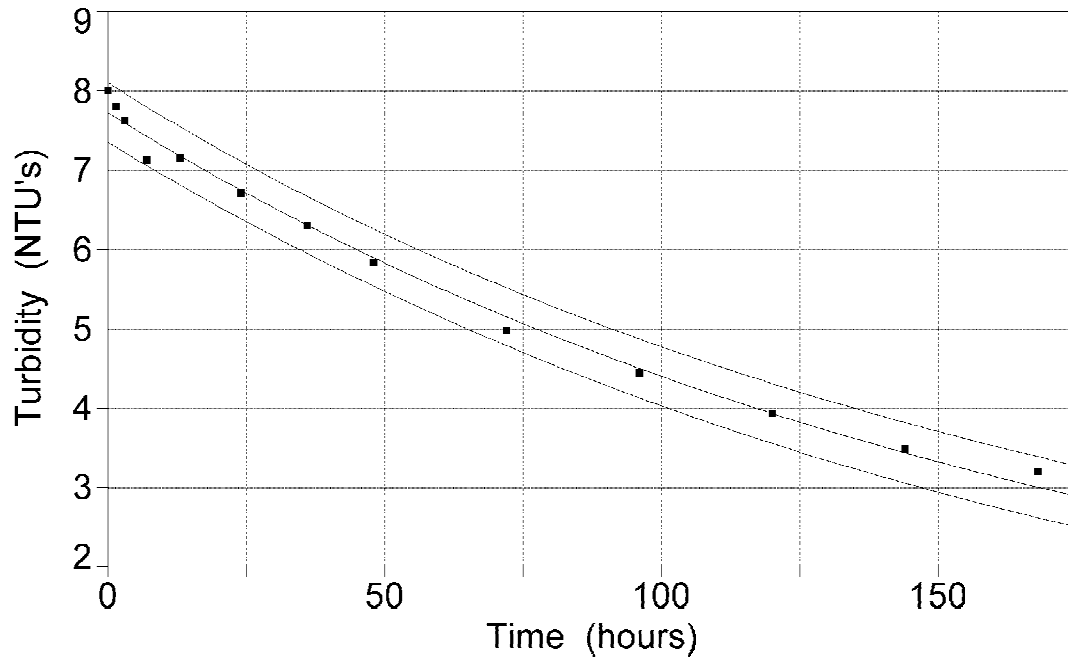
TDS 600 High Turbidity (Replicate 1)

y = a exp(-bx)

r² = 0.99439385   DF Adj r² = 0.99327262   FitStdErr = 0.45993237   Fstat = 1951.1318

a = 21.437514

b = 0.0082500643
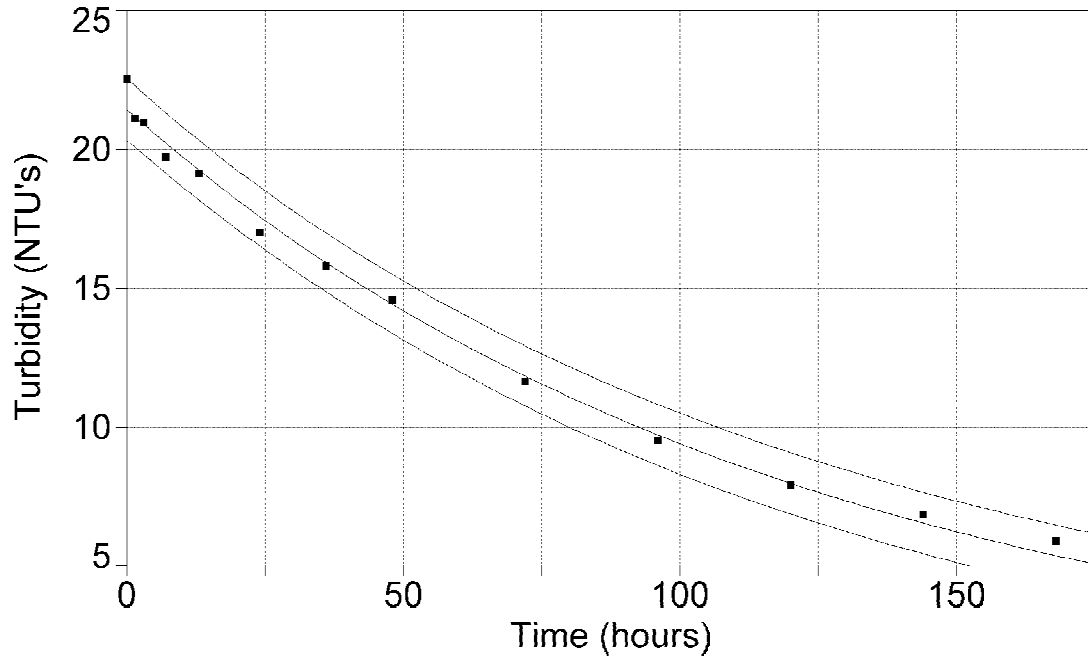
TDS 600 High Turbidity (Replicate 2)

y = a exp(-bx)

r² = 0.99415734   DF Adj r² = 0.9929888   FitStdErr = 0.4776839   Fstat = 1871.7032

a = 21.459332

b = 0.0085206996

B5
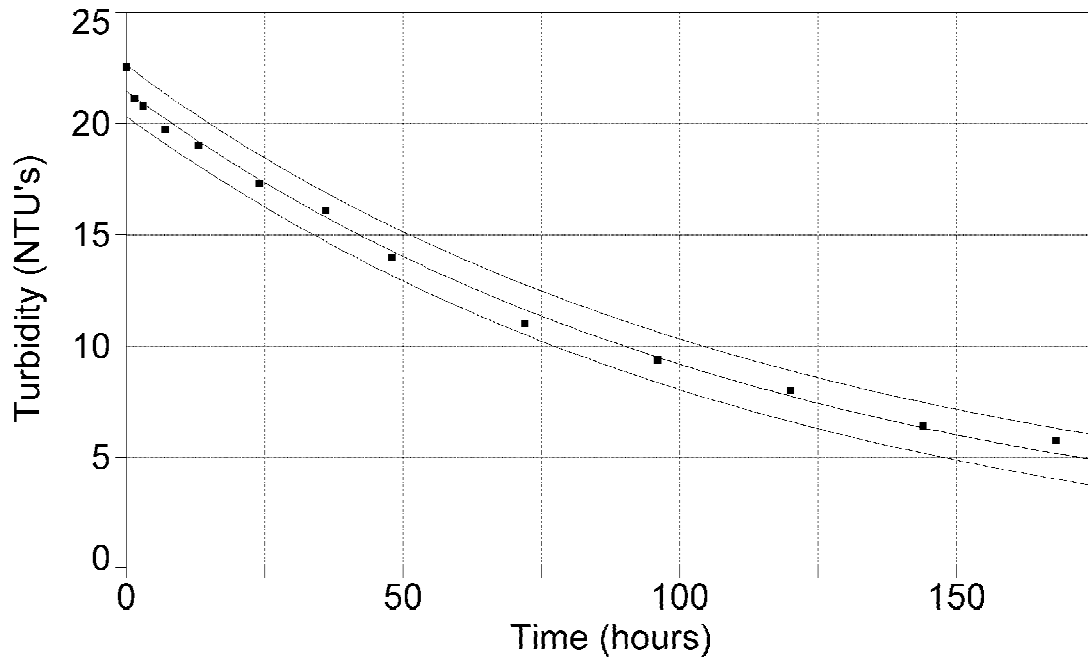
TDS 600 High Turbidity (Average)

y = a exp(-bx)

r² = 0.99479584   DF Adj r² = 0.99375501   FitStdErr = 0.44690236   Fstat = 2102.6956

a = 21.450549

b = 0.008383922
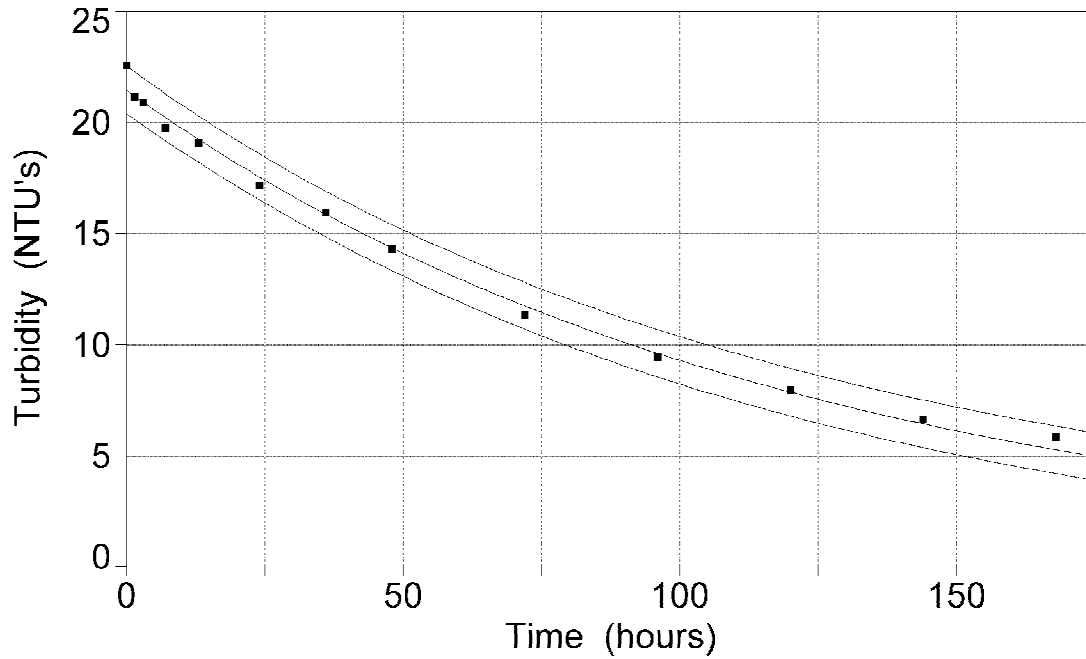
TDS 600 Very High Turbidity

y = a exp(-bx)

r² = 0.98701212   DF Adj r² = 0.98376515   FitStdErr = 1.6968019   Fstat = 683.95393

a = 42.749292

b = 0.012114533

B6
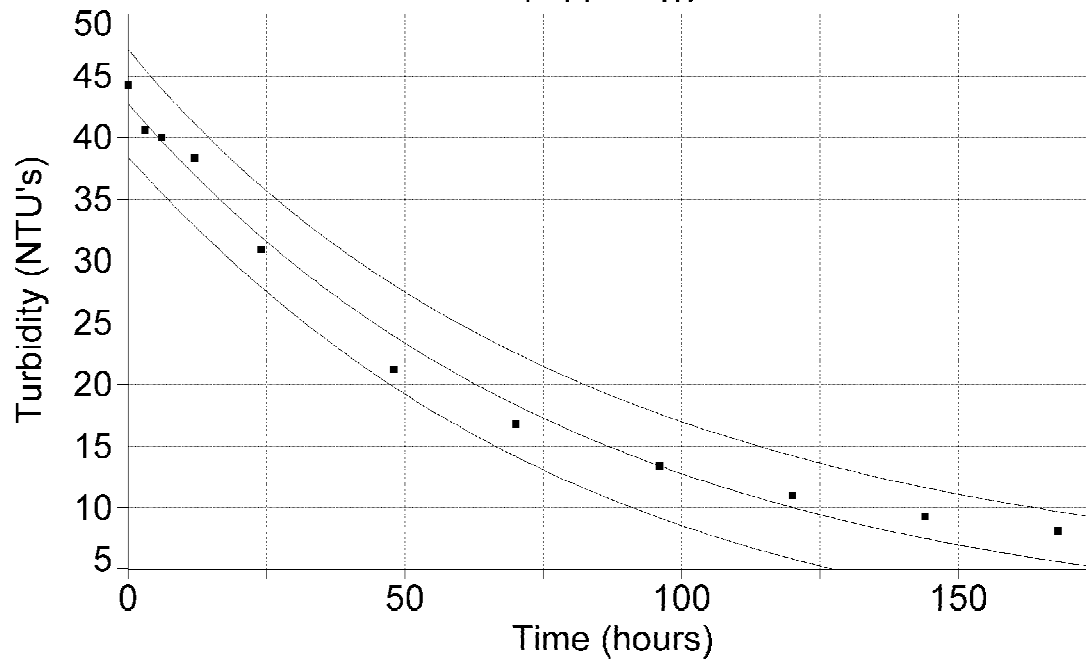
TDS 750 Low Turbidity (Replicate 1)

y = a exp(-bx)

r² = 0.98125846   DF Adj r² = 0.97657308   FitStdErr = 0.31661412   Fstat = 471.21677

a = 8.4658216

b = 0.0066556914
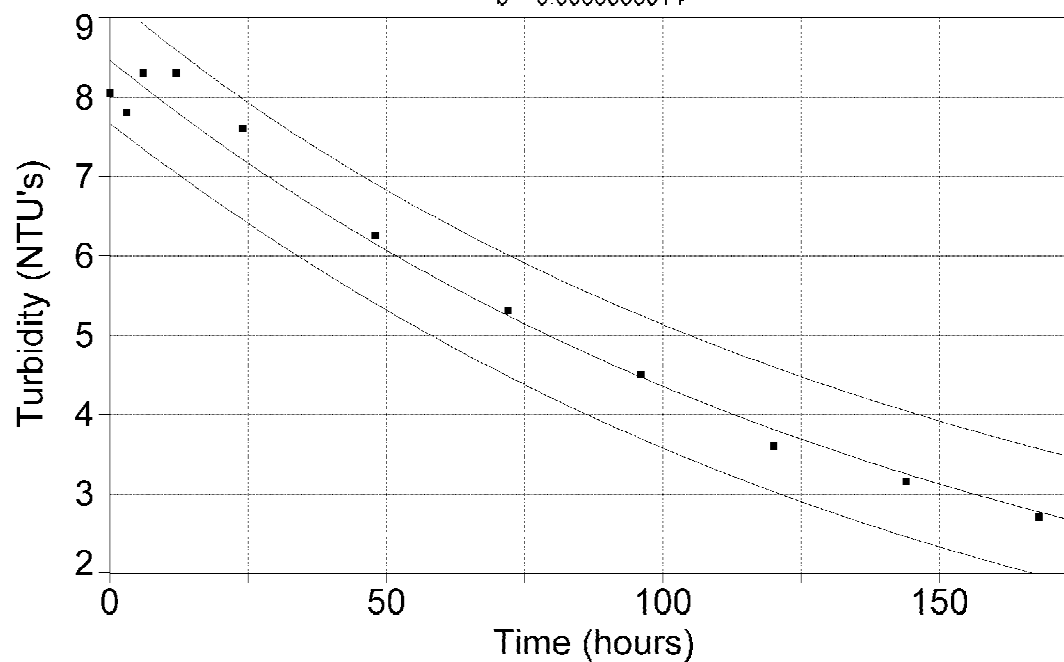
TDS 750 Low Turbidity (Replicate 2)

y = a exp(-bx)

r² = 0.98793837   DF Adj r² = 0.98492297   FitStdErr = 0.21246828   Fstat = 737.16801

a = 7.6787654

b =0.005907169
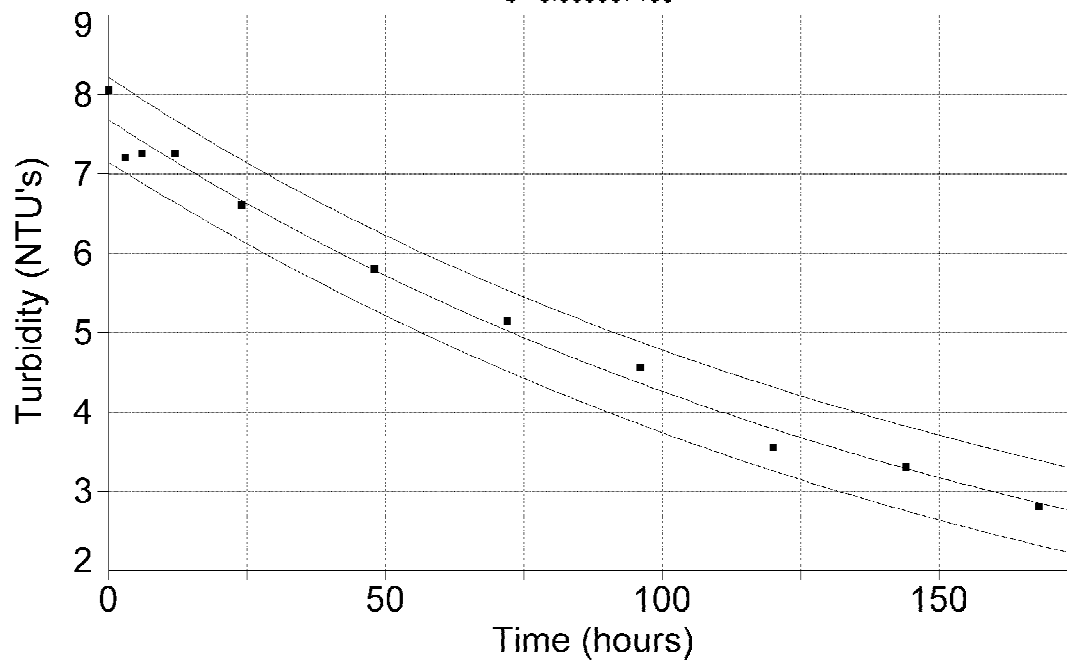
TDS 750 Low Turbidity (Replicate 3)

y = a exp(-bx)

r² = 0.98753568   DF Adj r² = 0.9844196   FitStdErr = 0.21708051   Fstat = 713.06094

a = 7.5350759

b = 0.0061262396
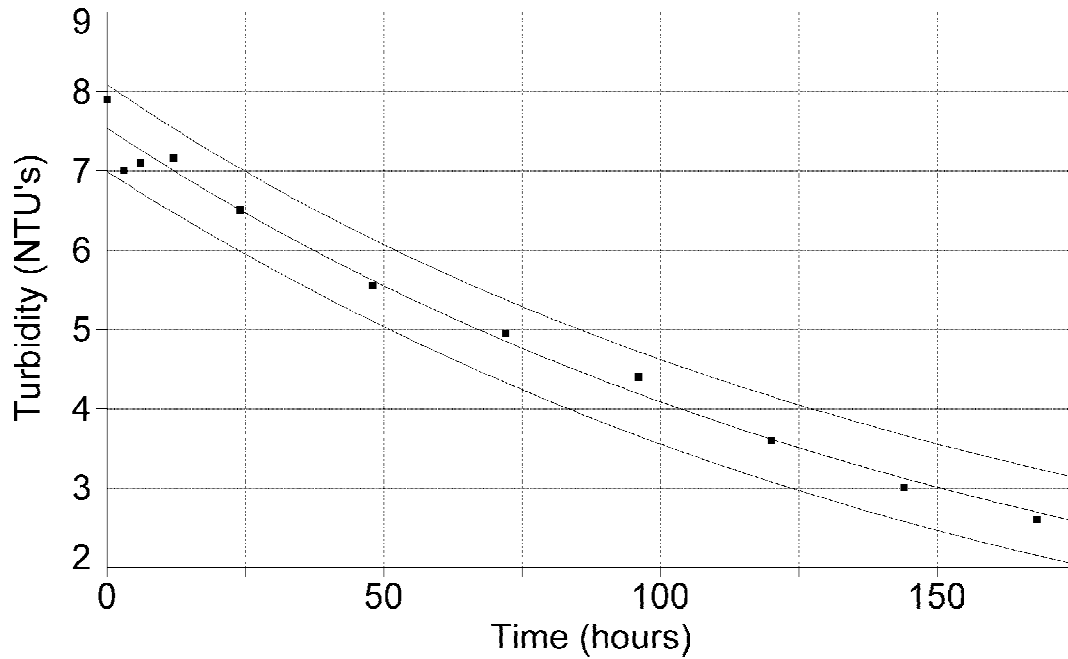
TDS 750 Low Turbidity (Average)

y = a exp(-bx)

r² = 0.99166922   DF Adj r² = 0.98958652   FitStdErr = 0.18779403   Fstat = 1071.331

a = 7.893257

b = 0.0062402408

B8
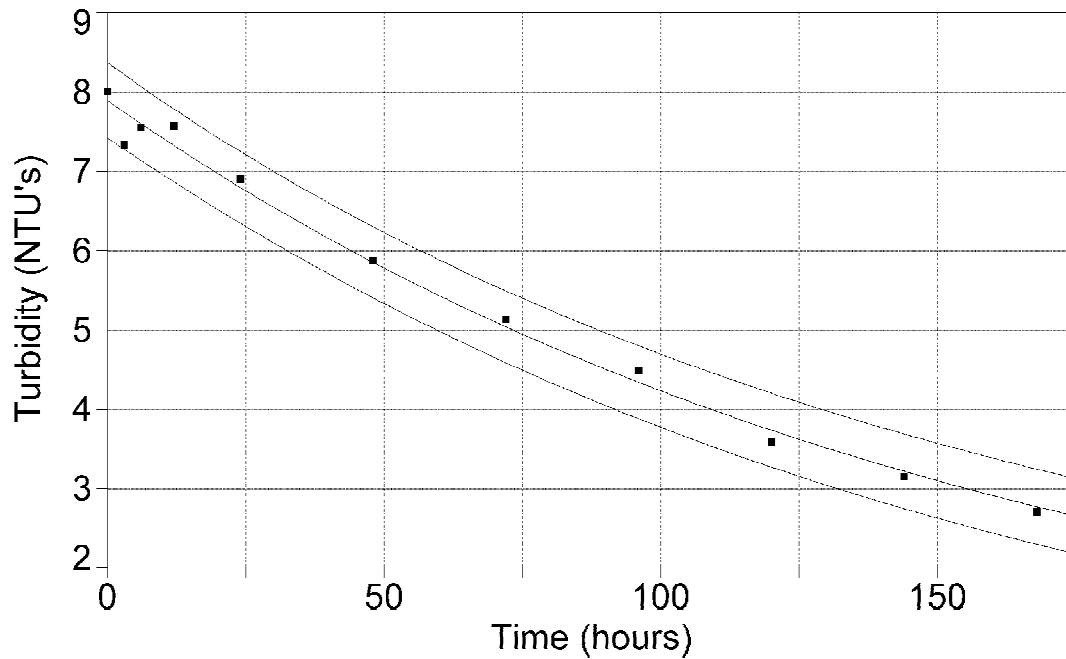
TDS 750 High Turbidity (Replicate 1)

y = a exp(-bx)

r² = 0.98657448   DF Adj r² = 0.98321809   FitStdErr = 0.83486141   Fstat = 661.36486

a = 21.810304

b = 0.010140995
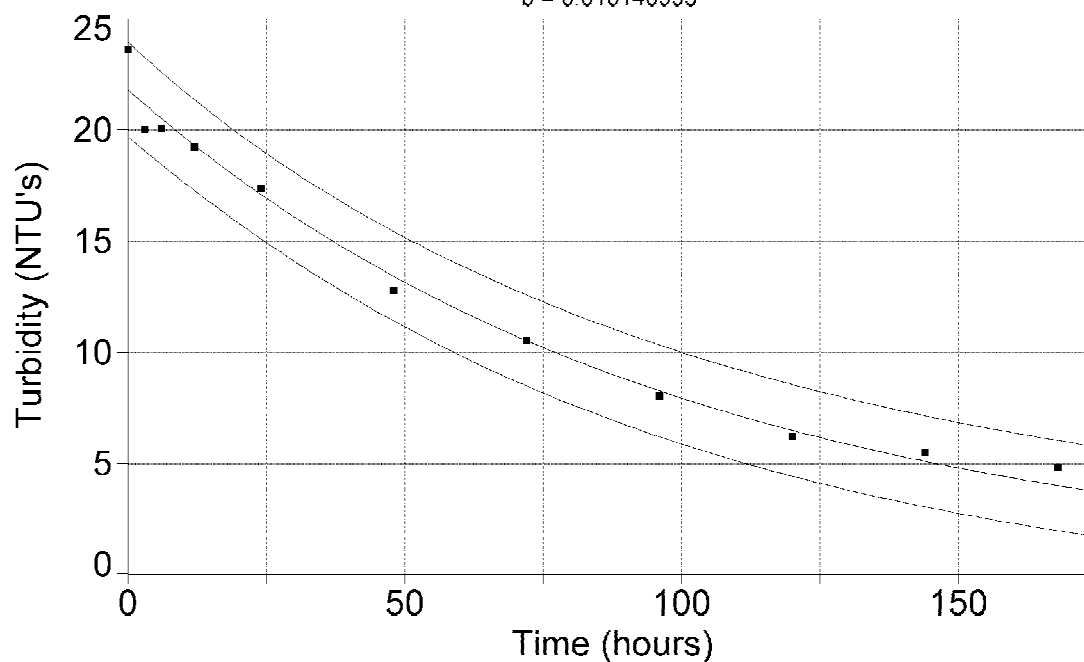
TDS 750 High Turbidity (Replicate 2)

y = a exp(-bx)

r² = 0.98650921   DF Adj r² = 0.98313651   FitStdErr = 0.91947073   Fstat = 658.12165

a = 23.578738

b = 0.010676362

B9
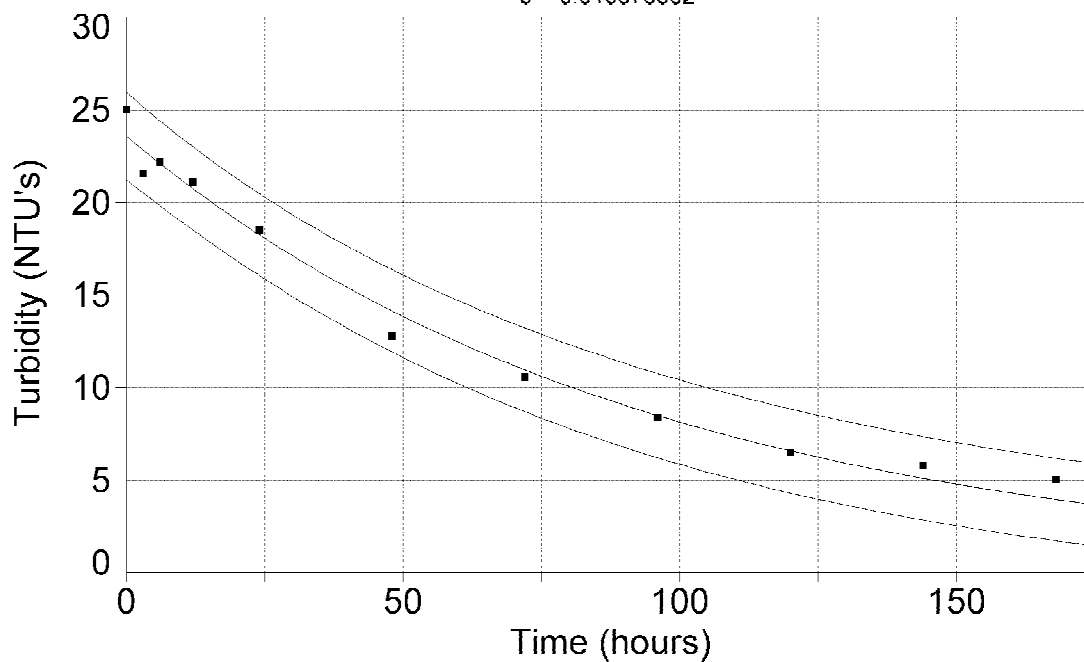
TDS 750 High Turbidity (Average)

y = a exp(-bx)

r² = 0.987211   DF Adj r² = 0.98401375   FitStdErr = 0.85469266   Fstat = 694.72982

a = 22.692904

b = 0.010413018
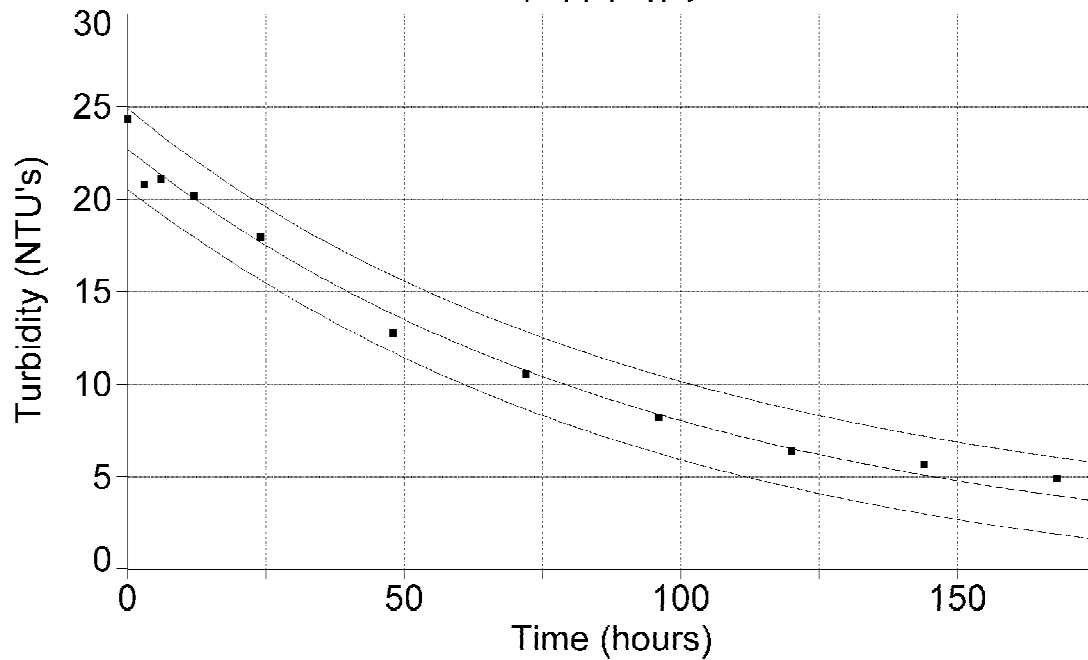
TDS 750 Very High Turbidity

y = a exp(-bx)

r² = 0.98152689   DF Adj r² = 0.97690862   FitStdErr = 1.9412247   Fstat = 478.19471

a = 40.565342

b = 0.01262179

B10

TDS 900 Low Turbidity (Replicate 1)

y = a exp(-bx)

r² = 0.99579416   DF Adj r² = 0.99485953   FitStdErr = 0.16517936   Fstat = 2367.6486

a = 8.5045137

b = 0.0080401018

TDS 900 Low Turbidity (Replicate 2)

y = a exp(-bx)

r² = 0.99369347   DF Adj r² = 0.99229202   FitStdErr = 0.18124299   Fstat = 1575.6574

a = 7.8009327

b = 0.0077414421
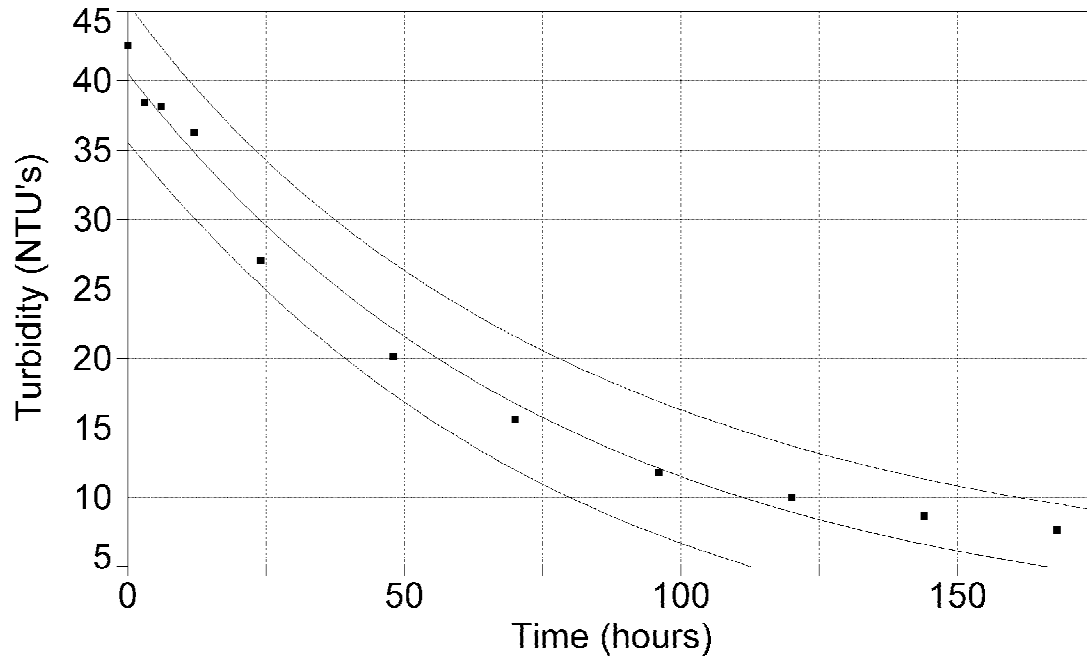
B11
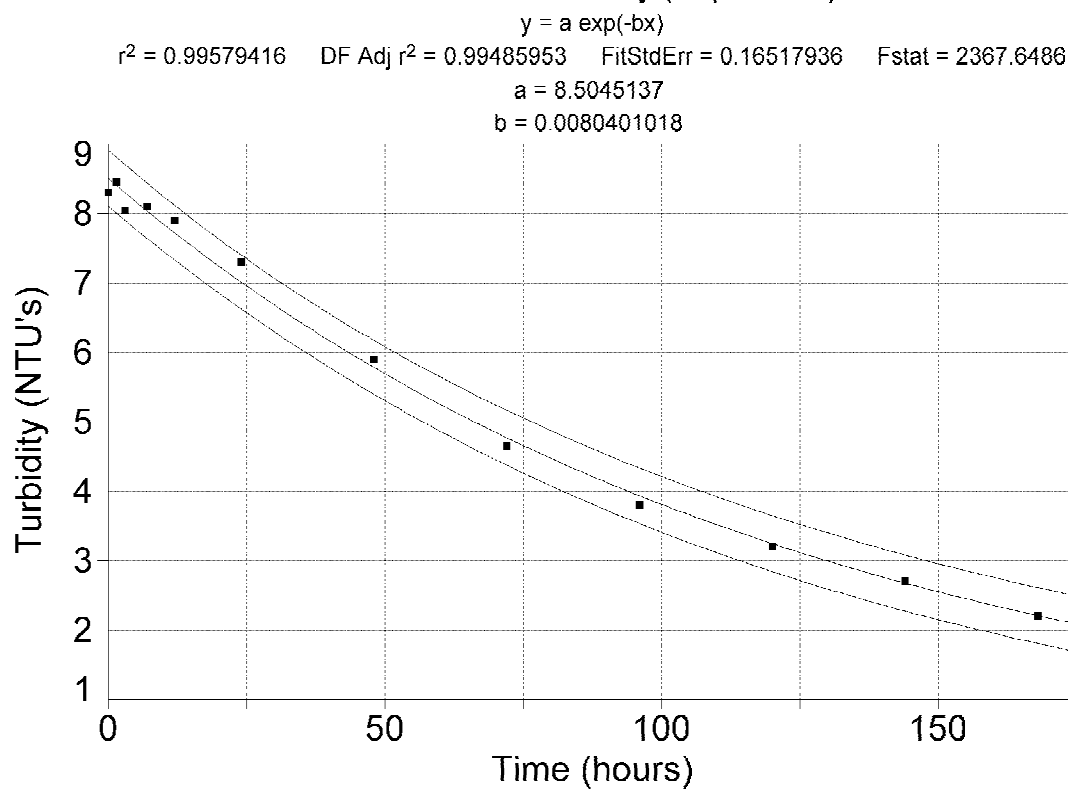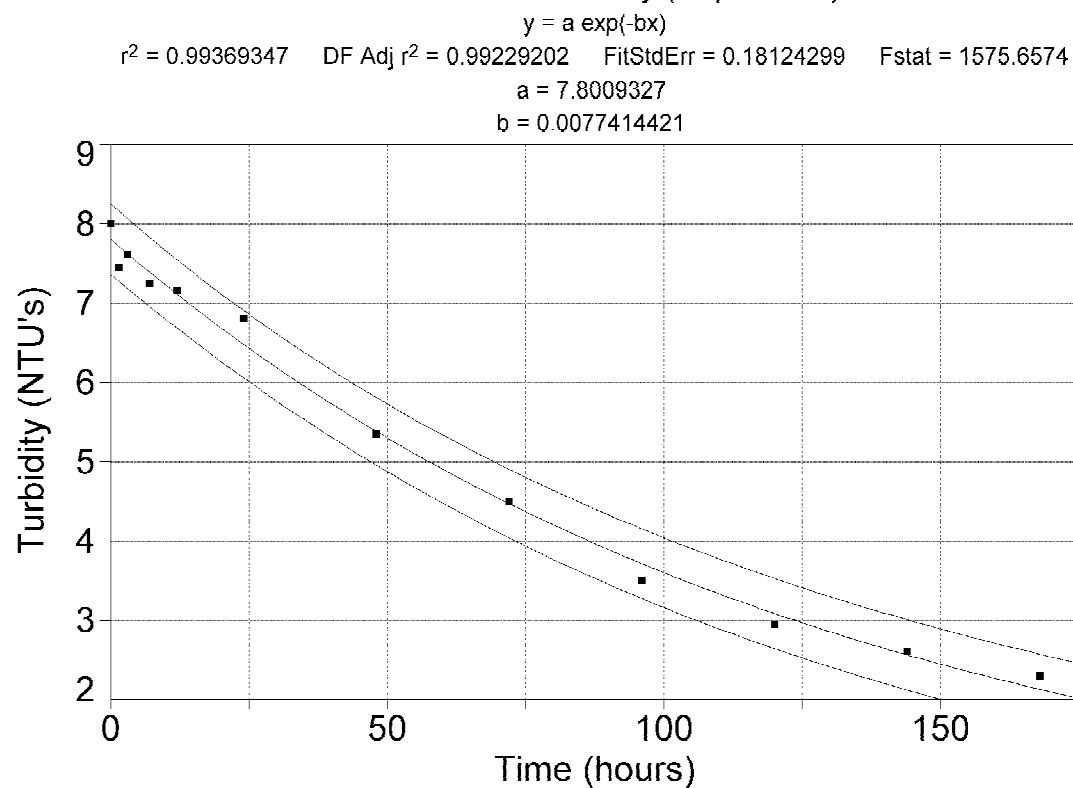
TDS 900 Low Turbidity (Replicate 3)

y = a exp(-bx)

r² = 0.99365143   DF Adj r² = 0.99224064   FitStdErr = 0.18126609   Fstat = 1565.1591

a = 7.8332751

b = 0.0077067523
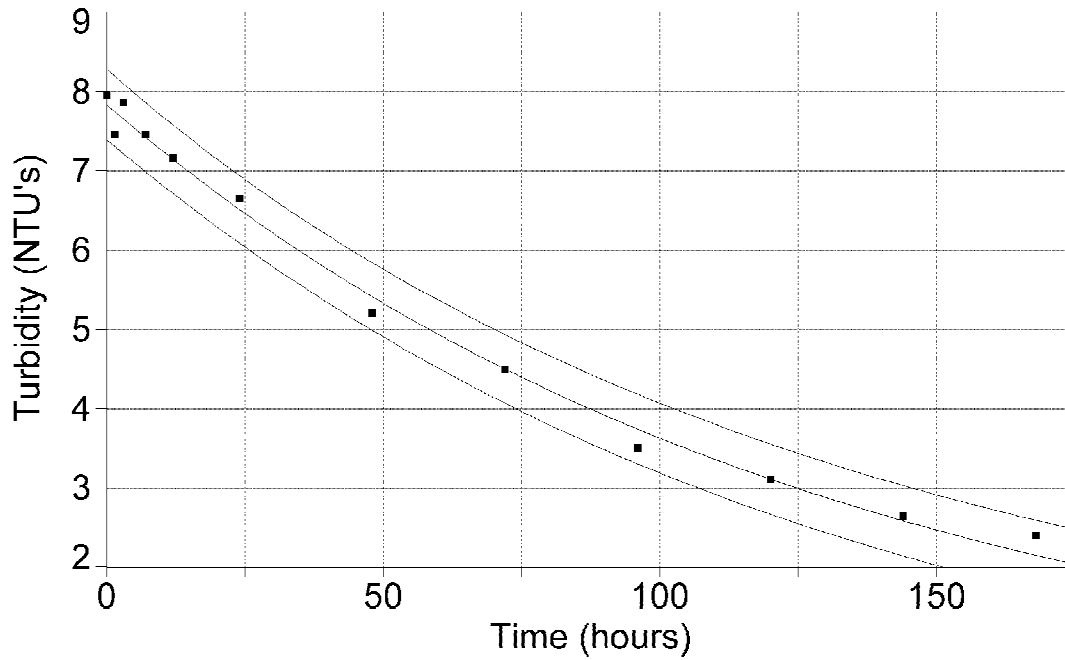
TDS 900 Low Turbidity (Average)

y = a exp(-bx)

r² = 0.99706104   DF Adj r² = 0.99640793   FitStdErr = 0.12821722   Fstat = 3392.5605

a = 8.0463965

b = 0.0078353741

B12
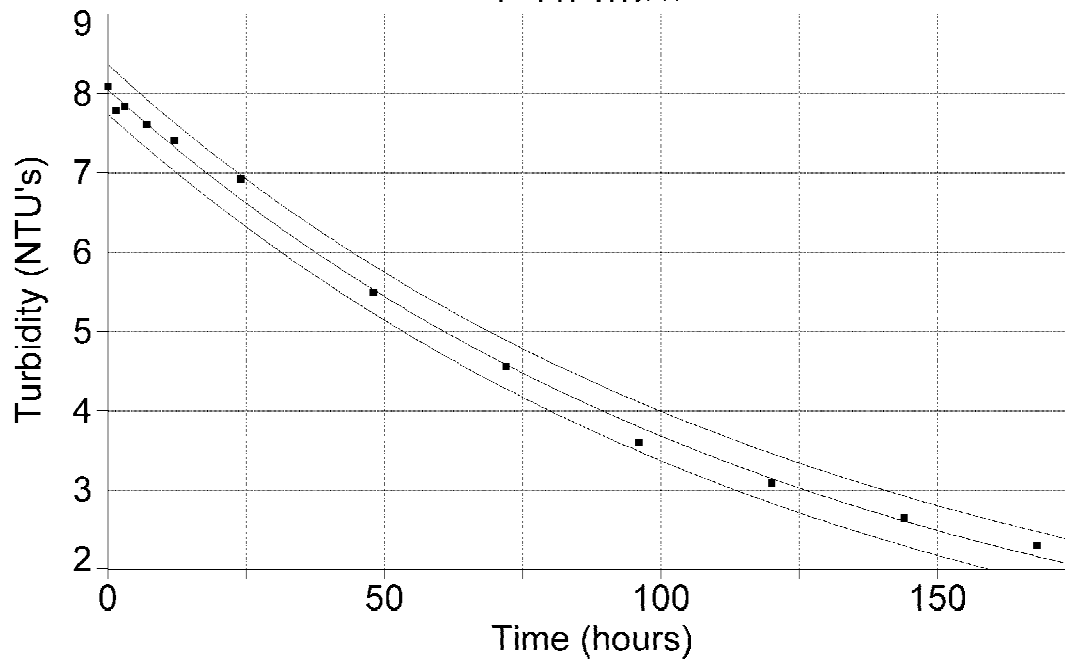
TDS 900 High Turbidity (Replicate 1)

y = a exp(-bx)

r² = 0.98535339   DF Adj r² = 0.98209858   FitStdErr = 0.84819832   Fstat = 672.75173

a = 21.308085

b = 0.0098574346
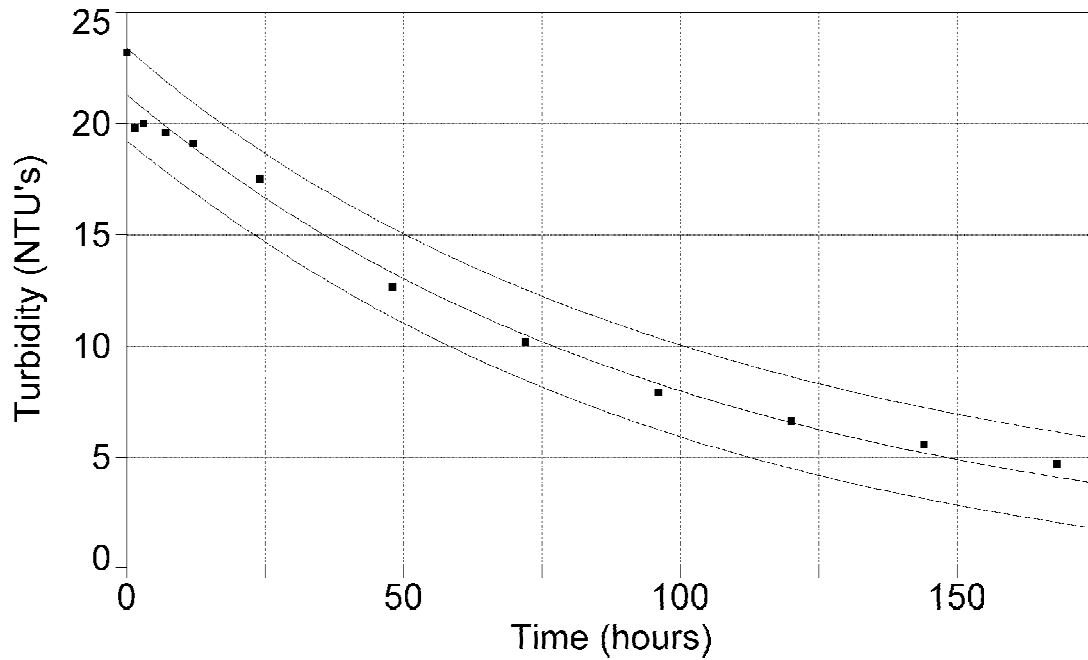
TDS 900 High Turbidity (Replicate 2)

y = a exp(-bx)

r² = 0.9900247   DF Adj r² = 0.98780797   FitStdErr = 0.72345563   Fstat = 992.47641

a = 21.696566

b = 0.010303663

B13
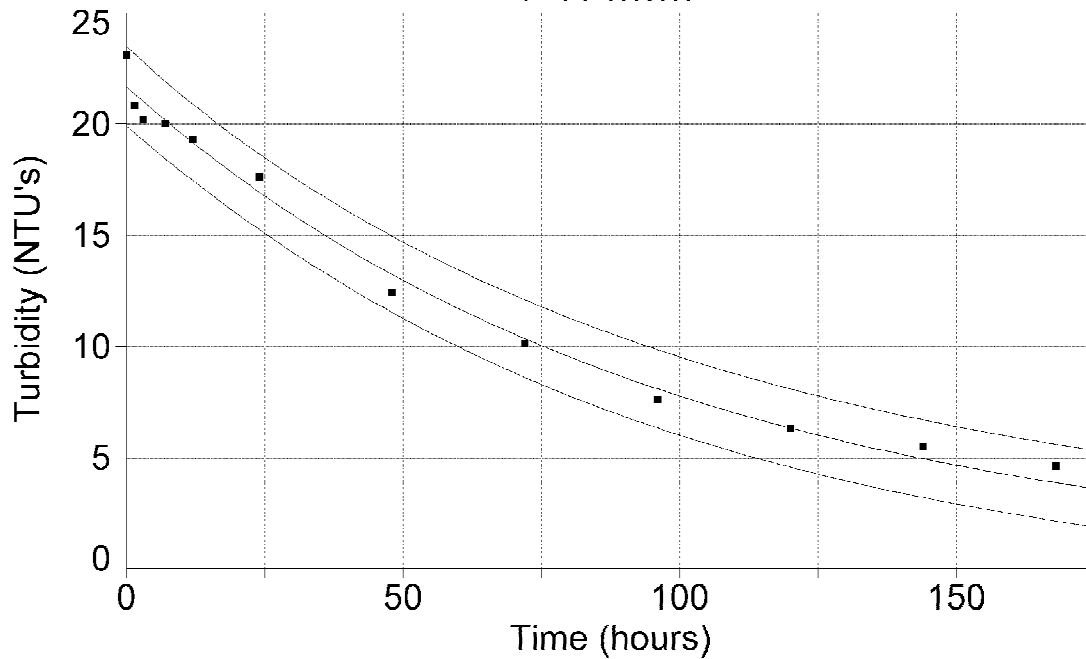
TDS 900 High Turbidity (Average)

y = a exp(-bx)

r² = 0.98817015   DF Adj r² = 0.98554129   FitStdErr = 0.77487043   Fstat = 835.31906

a = 21.501646

b = 0.01007905
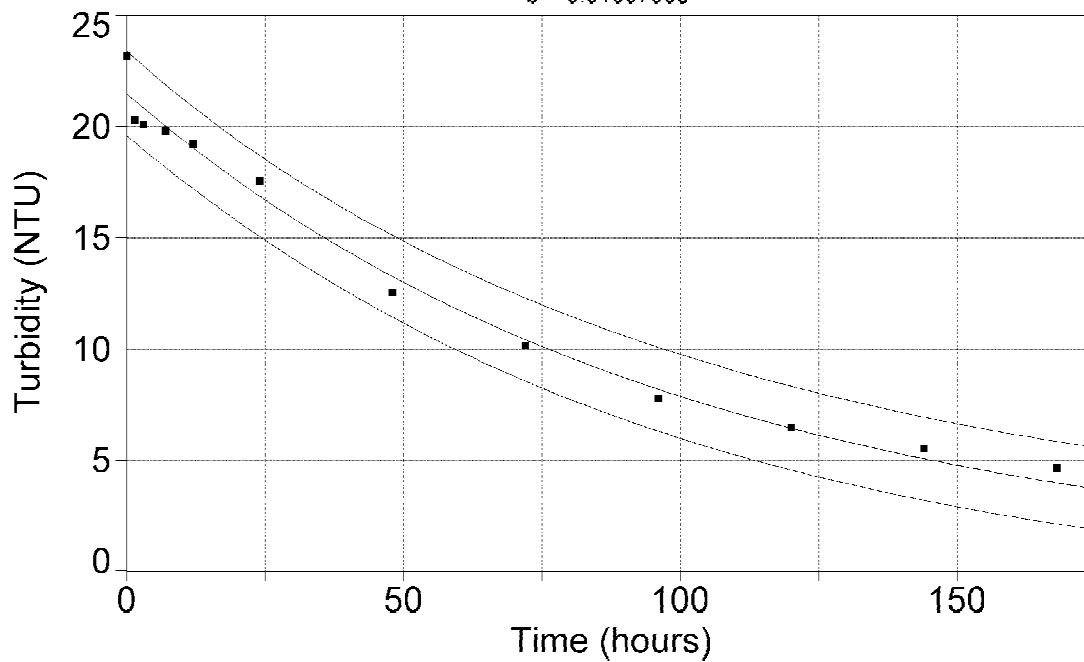
TDS 900 Very High Turbidity

y = a exp(-bx)

r² = 0.97850808   DF Adj r² = 0.9731351   FitStdErr = 2.159049   Fstat = 409.76207

a = 40.454176

b = 0.014246415

B14
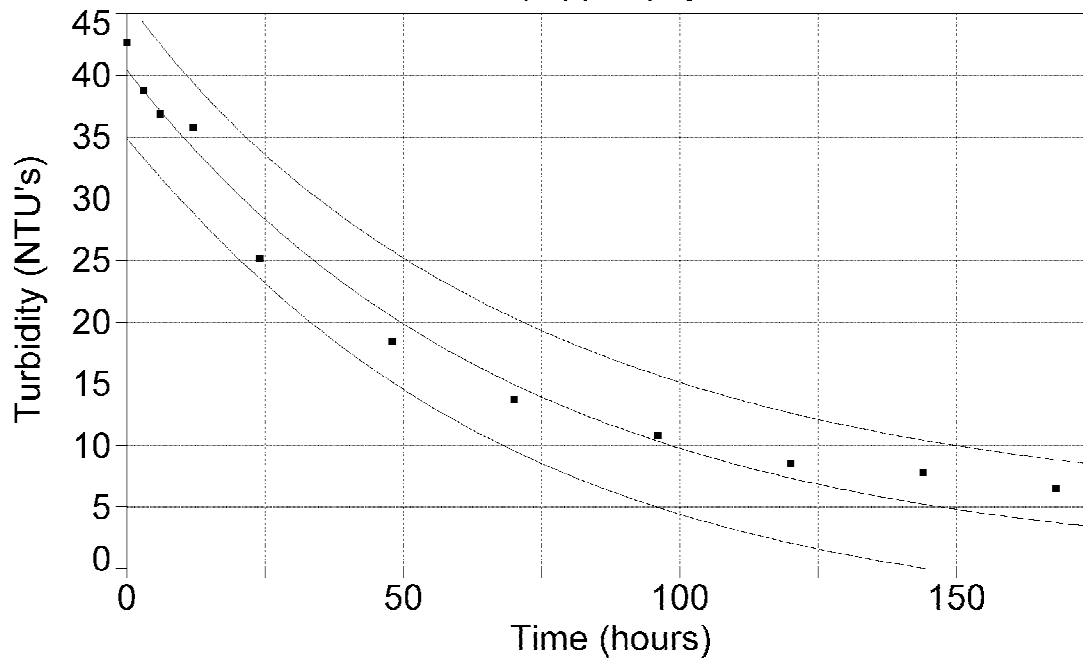
TDS 1050 Low Turbidity (Replicate 1)

y = a exp(-bx)

r² = 0.9861647   DF Adj r² = 0.98270588   FitStdErr = 0.27876576   Fstat = 641.51007

a = 8.229121

b = 0.00738512
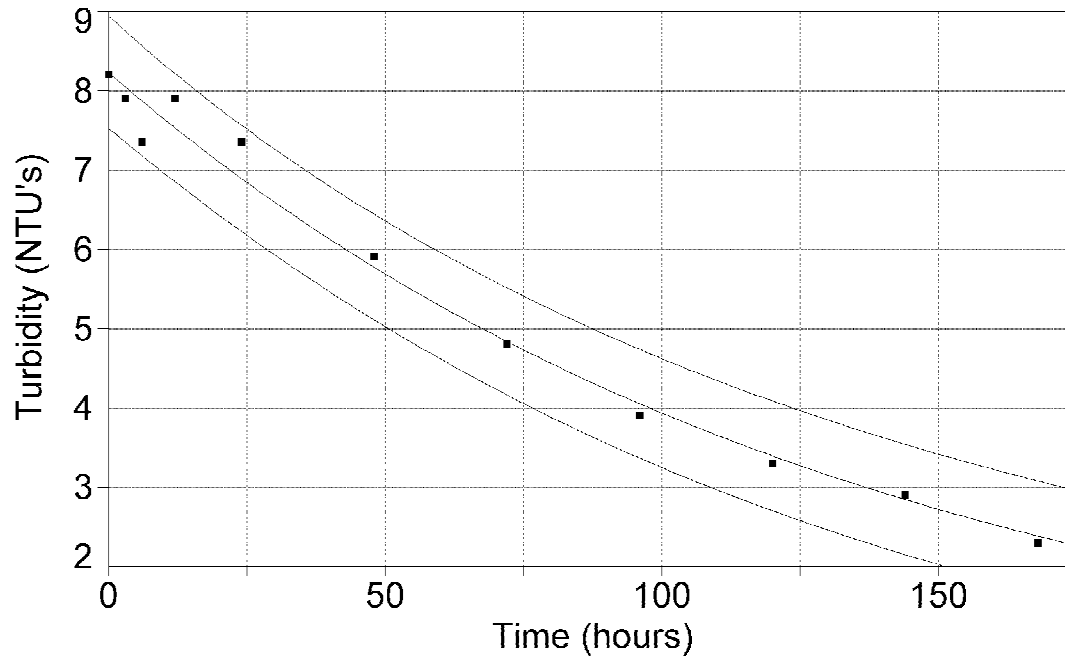
TDS 1050 Low Turbidity (Replicate 2)

y = a exp(-bx)

r² = 0.98573202   DF Adj r² = 0.98216502   FitStdErr = 0.2457312   Fstat = 621.78303

a = 7.5155402

b = 0.0068205232
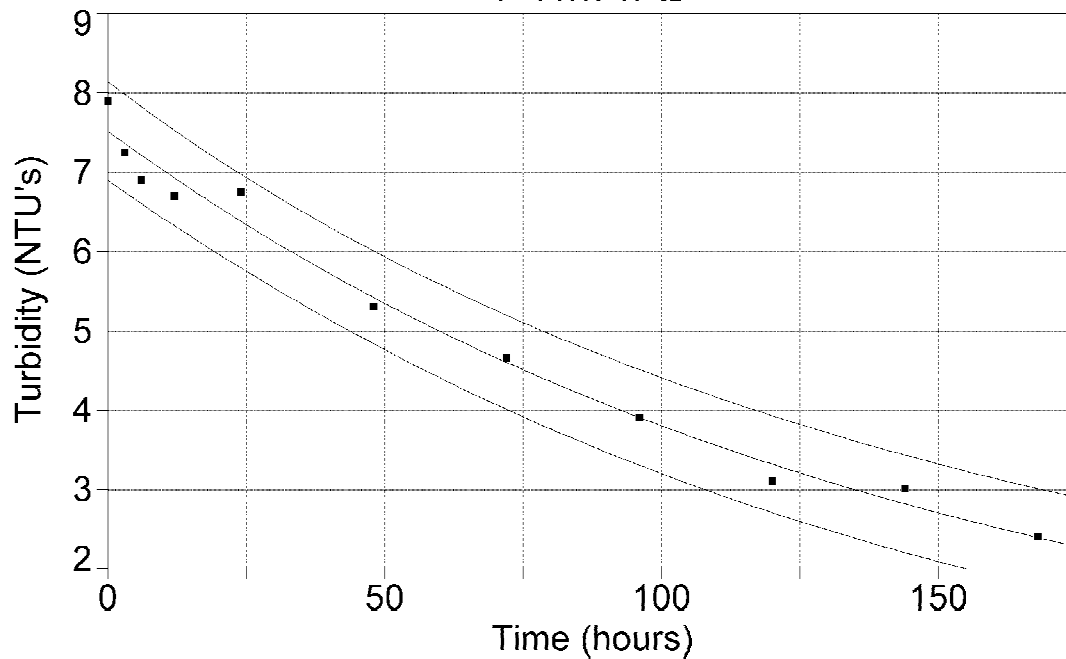
TDS 1050 Low Turbidity (Replicate 3)

y = a exp(-bx)

r² = 0.99515605   DF Adj r² = 0.99394506   FitStdErr = 0.13939369   Fstat = 1848.9877

a = 7.3835224

b = 0.0067738273
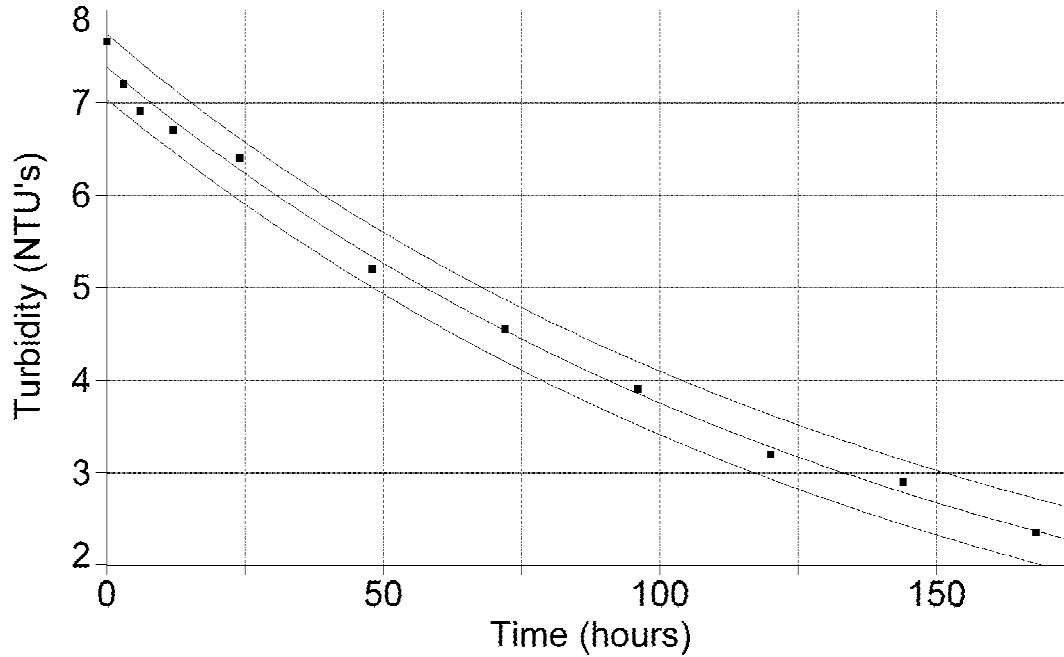
TDS 1050 Low Turbidity (Average)

y = a exp(-bx)

r² = 0.99259779   DF Adj r² = 0.99074723   FitStdErr = 0.18407252   Fstat = 1206.8527

a = 7.7095741

b = 0.0070040317

B16

TDS 1050 High Turbidity (Replicate 1)

y = a exp(-bx)

r² = 0.99037653   DF Adj r² = 0.98797066   FitStdErr = 0.76405506   Fstat = 926.21354

a = 22.198411

b = 0.011658998

TDS 1050 High Turbidity (Replicate 2)

y = a exp(-bx)

r² ≈ 0.98827607   DF Adj r² ≈ 0.98534509   Fit Std Err ≈ 0.83325026   Fstat ≈ 758.66061

a ≈ 21.783038

b = 0.011988634

B17

TDS 1050 High Turbidity (Average)

y = a exp(-bx)

r² = 0.98983695   DF Adj r² = 0.98729618   FitStdErr = 0.78027529   Fstat=876.56063

a = 21.990038

b = 0.01181962
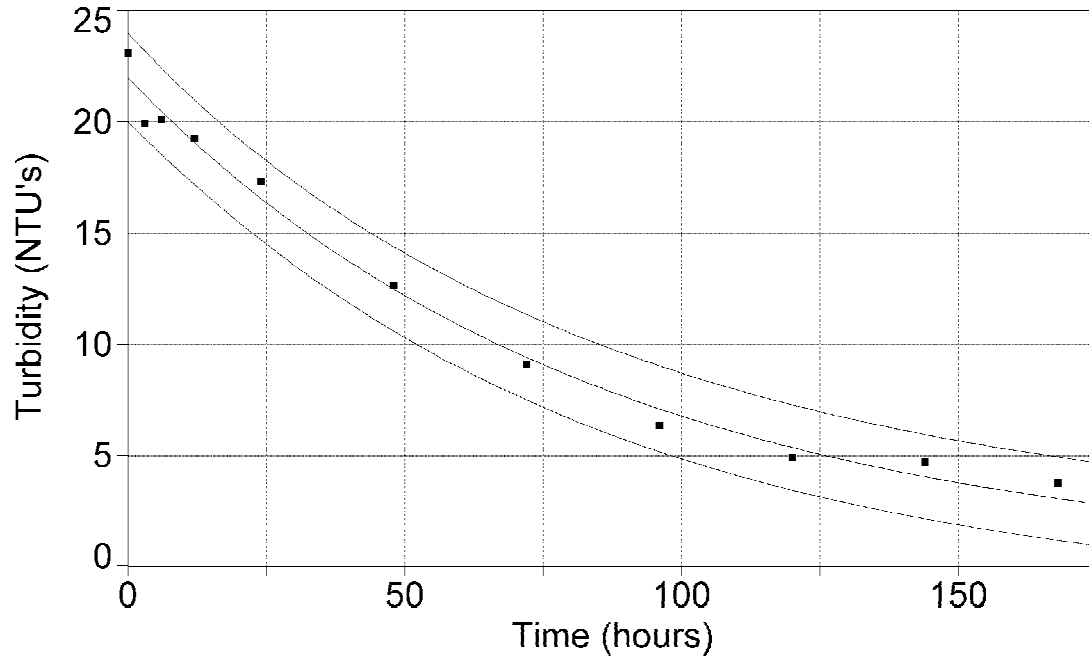
TDS 1050 Very High Turbidity

y = aexp(-bx)

r² = 0.98799254   DF Adj r² = 0.98499067   FitStdErr = 1.5572142   Fstat = 740.53377

a = 39.160655

b = 0.013837094

B18

TDS 1320 Low Turbidity (Replicate 1)

y = a exp(-bx)

r² = 0.99361278   DF Adj r² = 0.9921934   FitStdErr = 0.19804091   Fstat = 1555.626

a = 8.4232698

b = 0.0077410364

TDS 1320 Low Turbidity (Replicate 2)

y = a exp(-bx)

r² = 0.99423179   DF Adj r² = 0.99294997   FitStdErr = 0.19060049   Fstat = 1723.6401

a = 8.0553599

b = 0.0088107891

TDS 1320 Low Turbidity (Replicate 3)

y = a exp(-bx)

r² = 0.99258032   DF Adj r² = 0.9909315   FitStdErr = 0.19673018   Fstat = 1337.7666
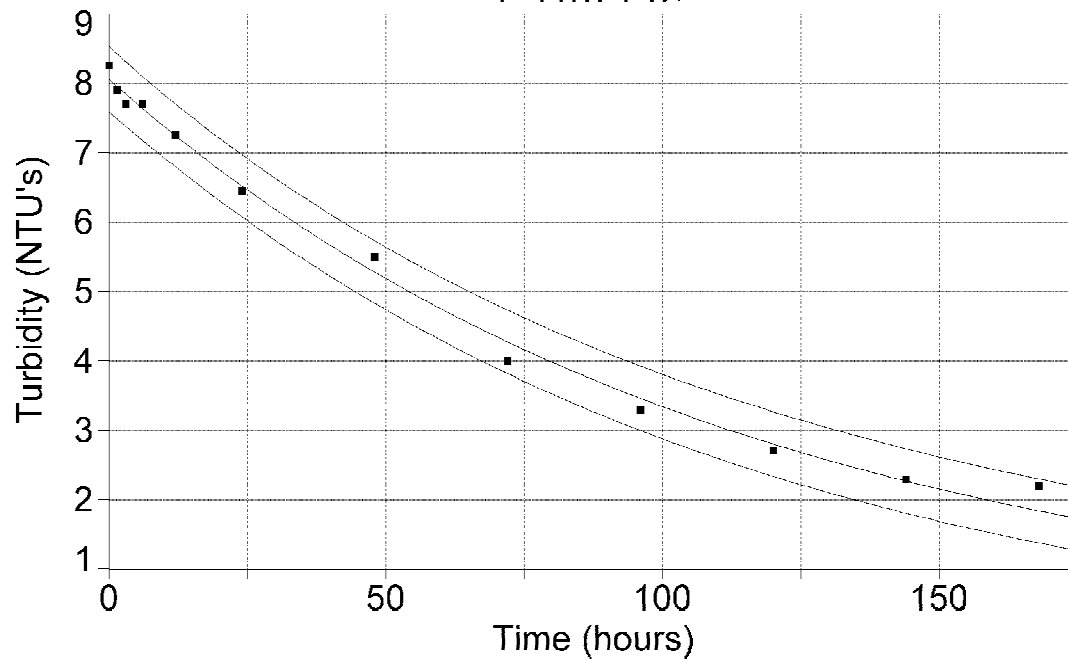
a = 7.6226828

b = 0.0080881608

$y = a\,\exp(-bx)$

$r^2 = 0.99258032 \quad \text{DF Adj } r^2 = 0.9909315 \quad \text{FitStdErr} = 0.19673018 \quad \text{Fstat} = 1337.7666$

$a = 7.6226828$

$b = 0.0080881608$
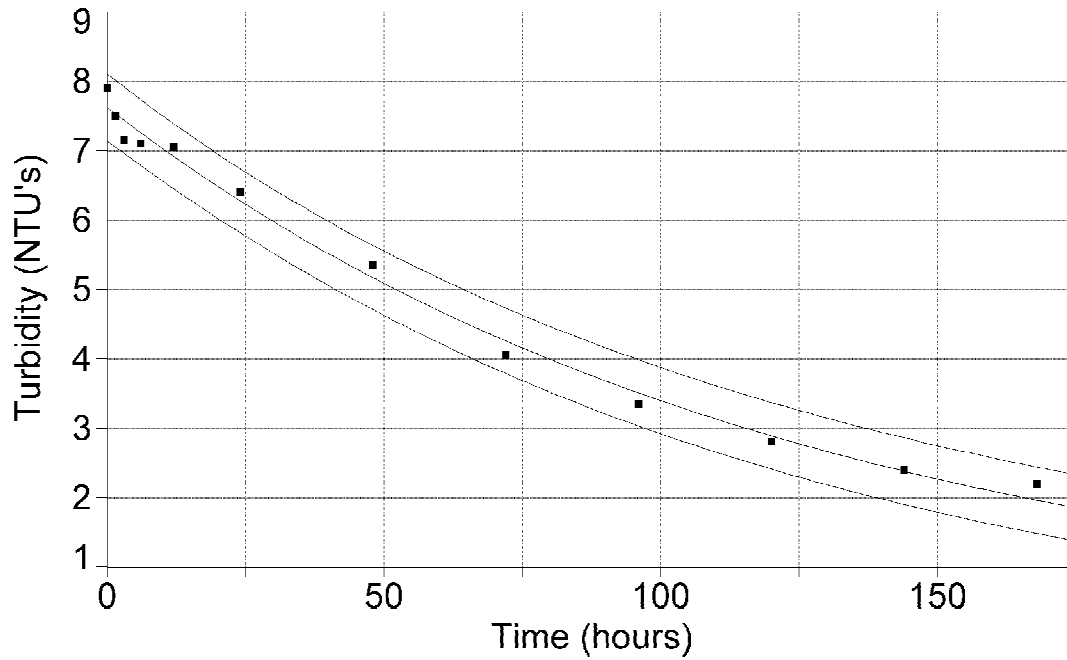
TDS 1320 Low Turbidity (Average)

$y = a\,\exp(-bx)$

$r^2 = 0.99613011 \quad \text{DF Adj } r^2 = 0.99527013 \quad \text{FitStdErr} = 0.15055571 \quad \text{Fstat} = 2574.0525$

$a = 8.0322648$

$b = 0.0081917796$

B20
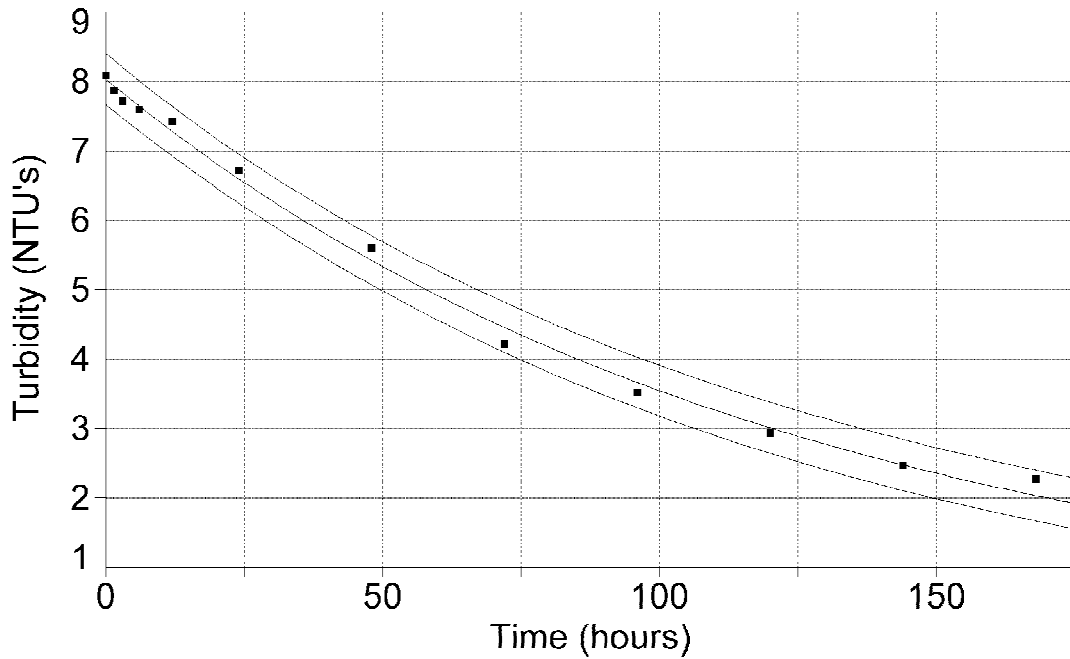
TDS 1320 High Turbidity (Replicate 1)

$$y = a \exp(-bx)$$

$r^2 = 0.99003374$ DF Adj $r^2 = 0.98781902$ FitStdErr $= 0.71471164$ Fstat $= 993.38591$

$a = 21.880439$
$b = 0.0097554055$
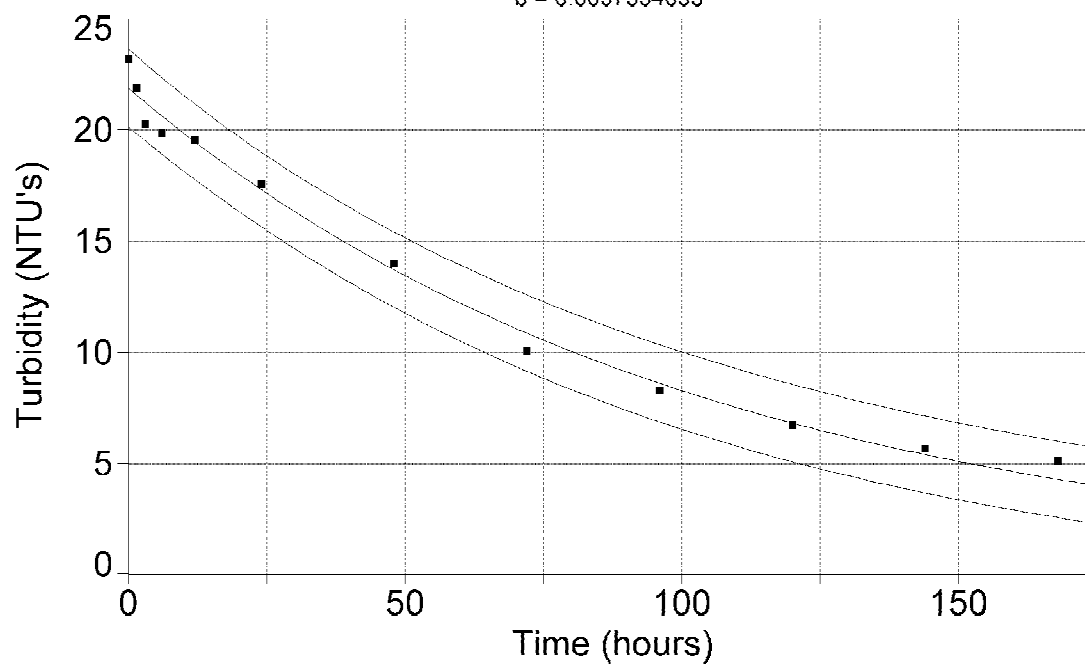
TDS 1320 High Turbidity (Replicate 2)

$$y = a \exp(-bx)$$

$r^2 = 0.98815509$ DF Adj $r^2 = 0.98552289$ FitStdErr $= 0.81104516$ Fstat $= 834.24448$

$a = 22.868988$
$b = 0.0097053982$

B21
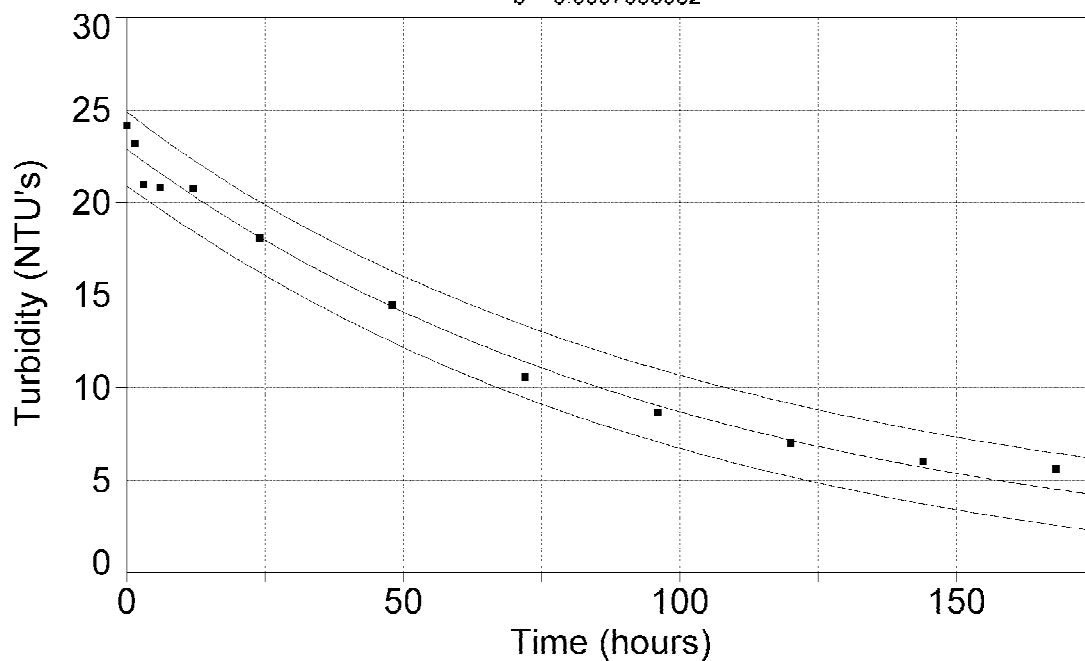
TDS 1320 High Turbidity (Average)

y = a exp(-bx)

r² = 0.98926995   DF Adj r² = 0.98688549   FitStdErr = 0.75669192   Fstat = 921.96177

a = 22.374746

b = 0.0097299079
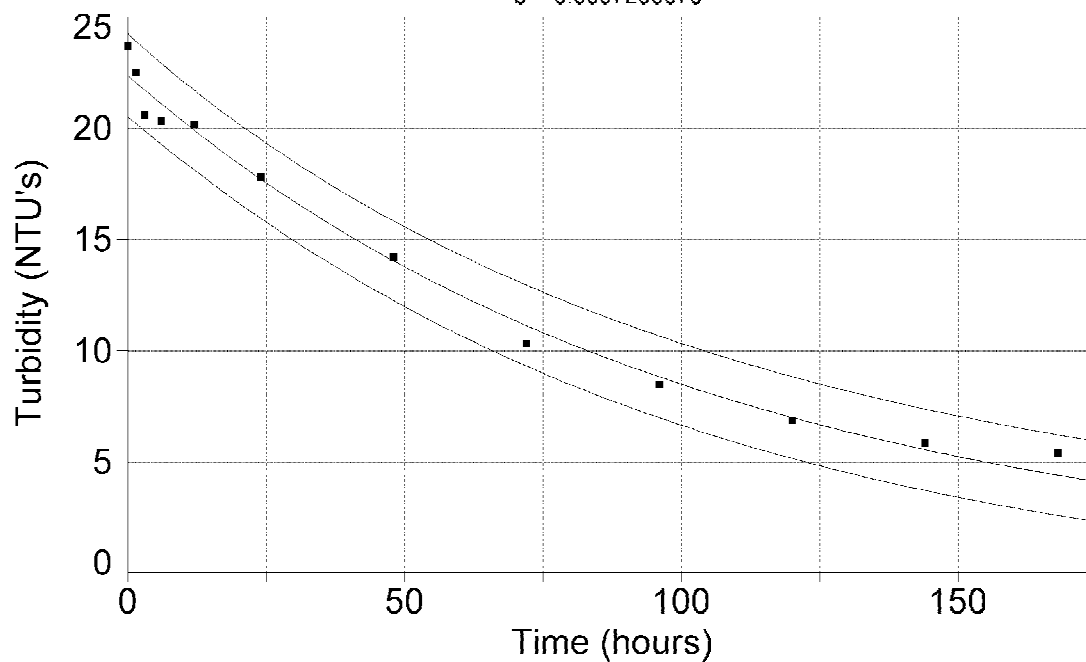
TDS 1320 Very High Turbidity

y = a exp(-bx)

r² = 0.98676495   DF Adj r² = 0.98345619   FitStdErr = 1.8133081   Fstat = 671.01271

a = 2.291202

b = 0.015148797

B22

TDS 1592 Low Turbidity (Replicate 1)

y = a exp(-bx)

r² = 0.98994387   DF Adj r² = 0.98742984   FitStdErr = 0.25085963   Fstat = 885.97645

a = 8.3093875

b = 0.0080665709

TDS 1592 Low Turbidity (Replicate 2)

y = a exp(-bx)

r² = 0.98322255   DF Adj r² = 0.97902819   FitStdErr = 0.30114176   Fstat = 527.43428

a = 7.8299982

b = 0.0078651753

B23
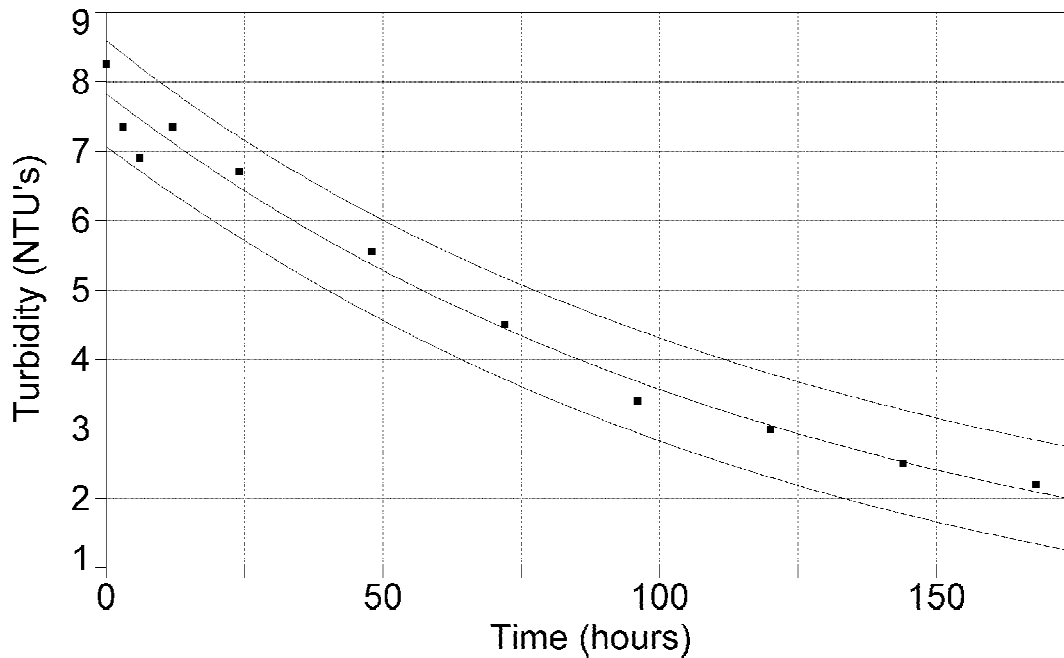
TDS 1592 Low Turbidity (Replicate 3)

y = a exp(-bx)

r² = 0.98845856   DF Adj r² = 0.9855732   FitStdErr = 0.25131469   Fstat = 770.79873

a = 7.7842955

b = 0.0080895403
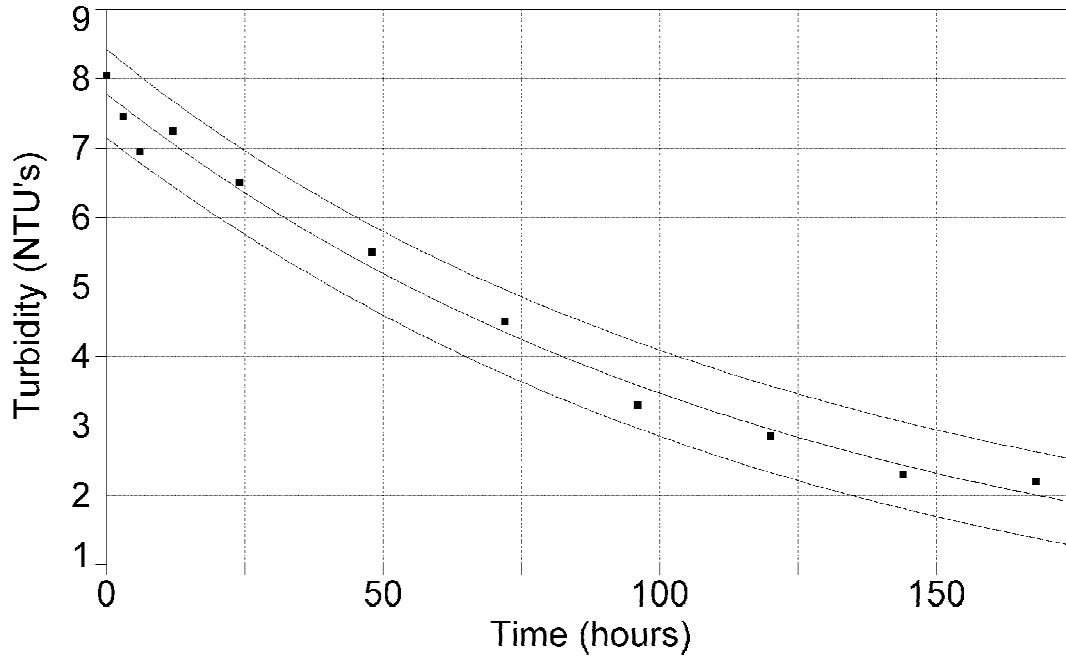
TDS 1592 Low Turbidity (Average)

y = a exp(-bx)

r² = 0.98905823   DF Adj r² = 0.98632279   FitStdErr = 0.24963225   Fstat = 813.53611

a = 7.974569

b = 0.0080077773

B24

TDS 1592 High Turbidity (Replicate 1)

y = a exp(-bx)

r² = 0.98159352   DF Adj r² = 0.97699189   FitStdErr = 1.0936422   Fstat = 479.95811

a = 22.199299

b = 0.012997117

TDS 1592 High Turbidity (Replicate 2)

y = a exp(-bx)

r² = 0.98152284   DF Adj r² = 0.97690355   FitStdErr = 1.1415349   Fstat = 478.0878

a = 23.14706

b = 0.01295177

B25
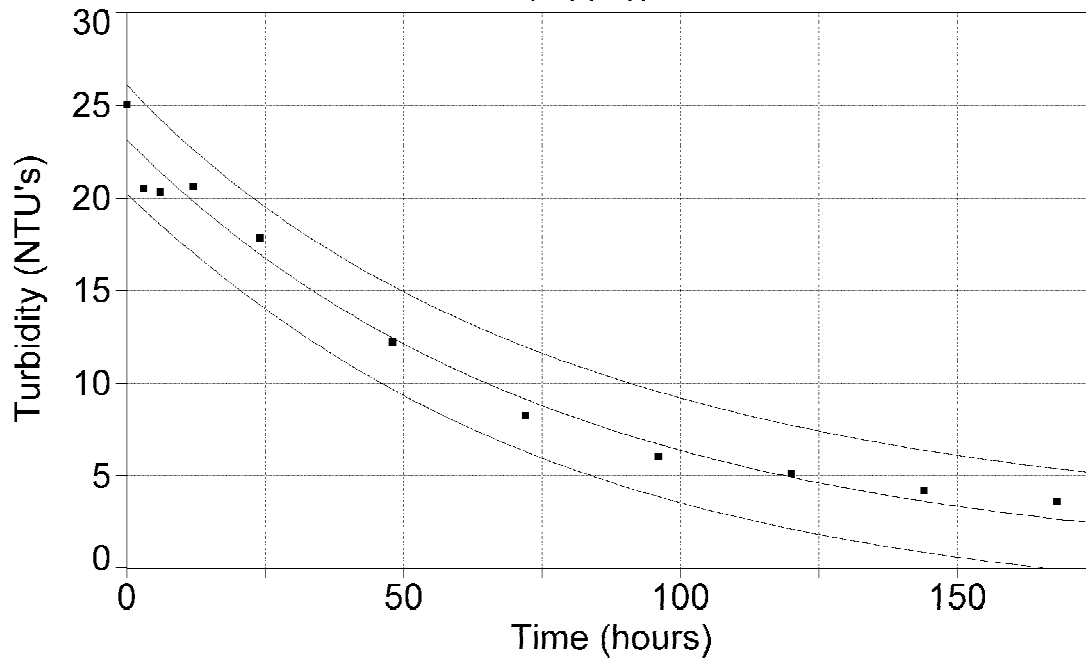
TDS 1592 High Turbidity (Average)

y = a exp(-bx)

r² = 0.98178798   DF Adj r² = 0.97723498   FitStdErr = 1.1104517   Fstat = 485.17915

a = 22.673159

b = 0.012973898
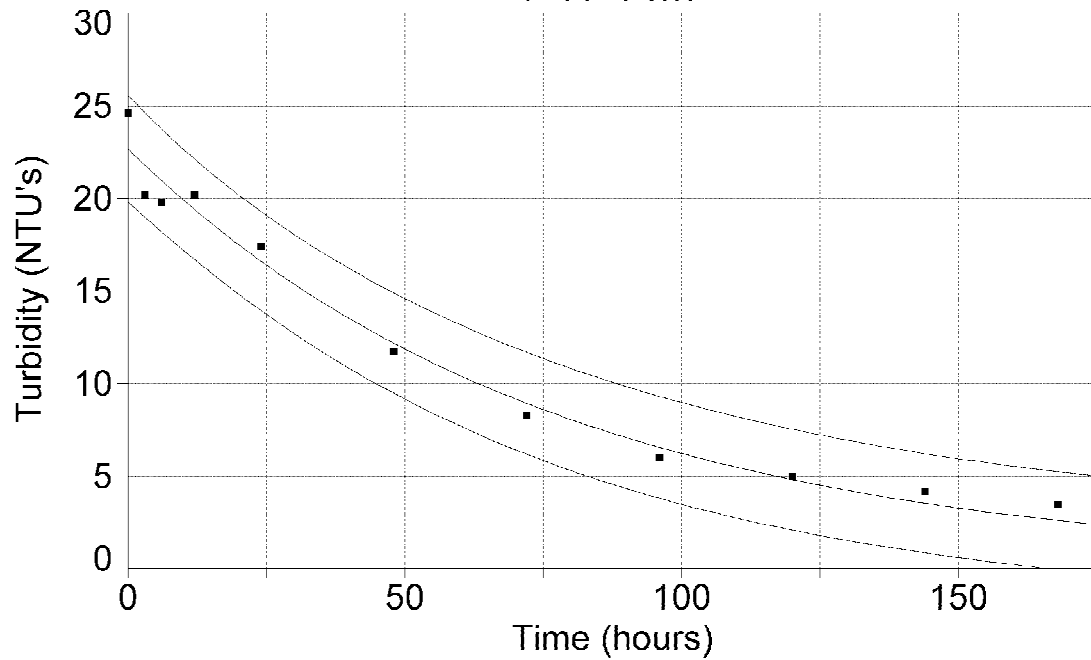
TDS 1592 Very High Turbidity

y = a exp(-bx)

r² = 0.98229829   DF Adj r² = 0.97787286   FitStdErr = 2.1409522   Fstat = 499.42534

a = 41.809654

b = 0.017166918

B26

TDS 1857 Low Turbidity (Replicate 1)

y = a exp(-bx)

r² = 0.98659055   DF Adj r² = 0.98390867   FitStdErr = 0.27119481   Fstat = 809.3173

a = 7.619579

b = 0.0096444264

TDS 1857 Low Turbidity (Replicate 2)

y = a exp(-bx)

r² = 0.99308691   DF Adj r² = 0.99170429   FitStdErr = 0.19103058   Fstat = 1580.1844

a = 7.6982914

b = 0.0089611731

B27
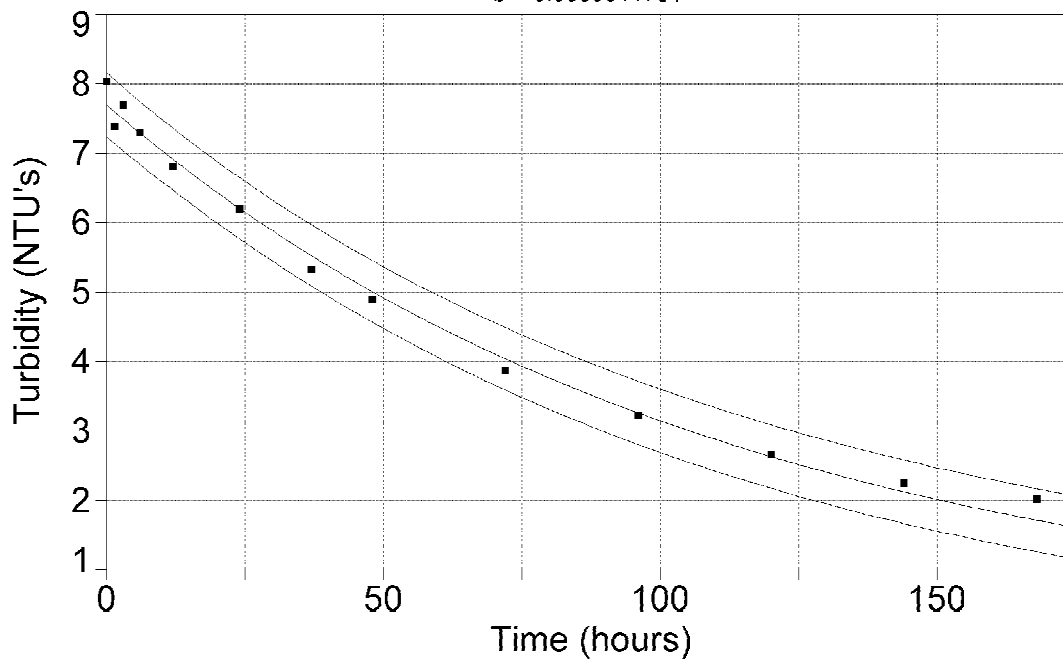
TDS 1857 Low Turbidity (Replicate 3)

y = a exp(-bx)

r² = 0.99323092   DF Adj r² = 0.9918771   FitStdErr = 0.19157838   Fstat = 1614.0356

a = 7.5597438

b = 0.0095440686
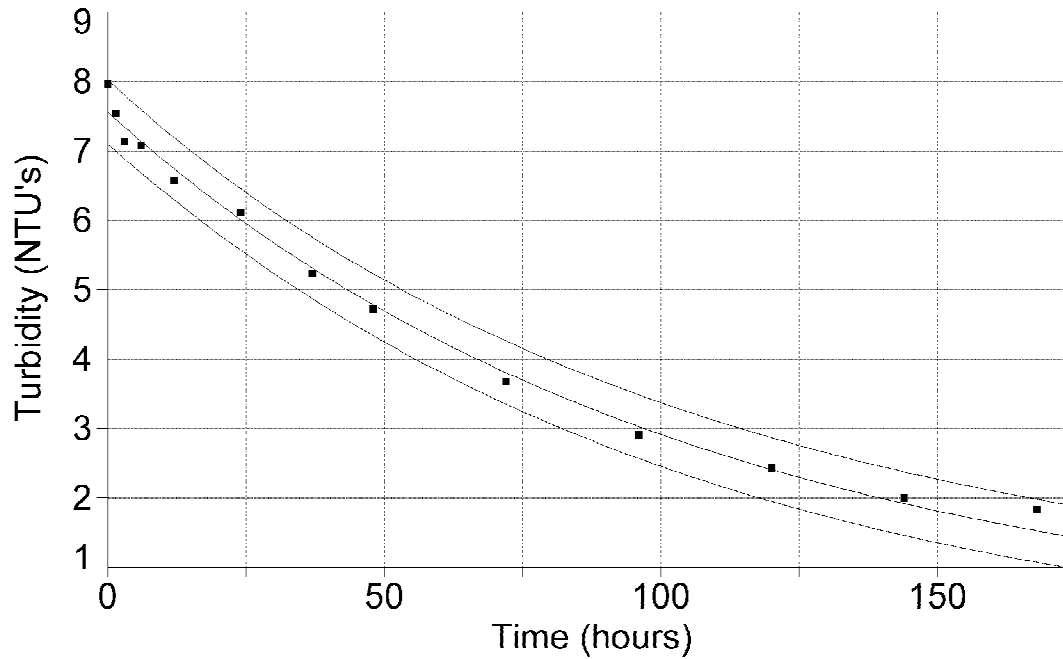
TDS 1857 Low Turbidity (Average)

y = a exp(-bx)

r² = 0.99272634   DF Adj r² = 0.99127161   FitStdErr = 0.19790309   Fstat = 1501.3056

a = 7.6252721

b = 0.0093742855

B28
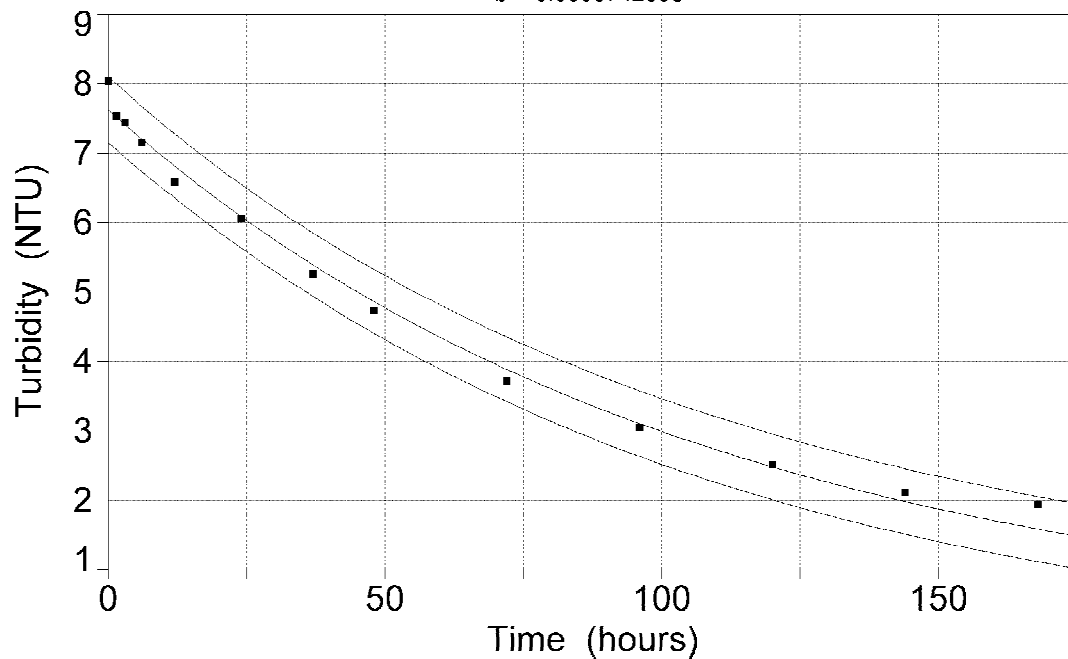
TDS 1857 High Turbidity (Replicate 1)

y = a exp(-bx)

r² = 0.99811649   DF Adj r² = 0.99773979   FitStdErr = 0.33866006   Fstat = 5829.1595

a = 21.902874

b = 0.013847326
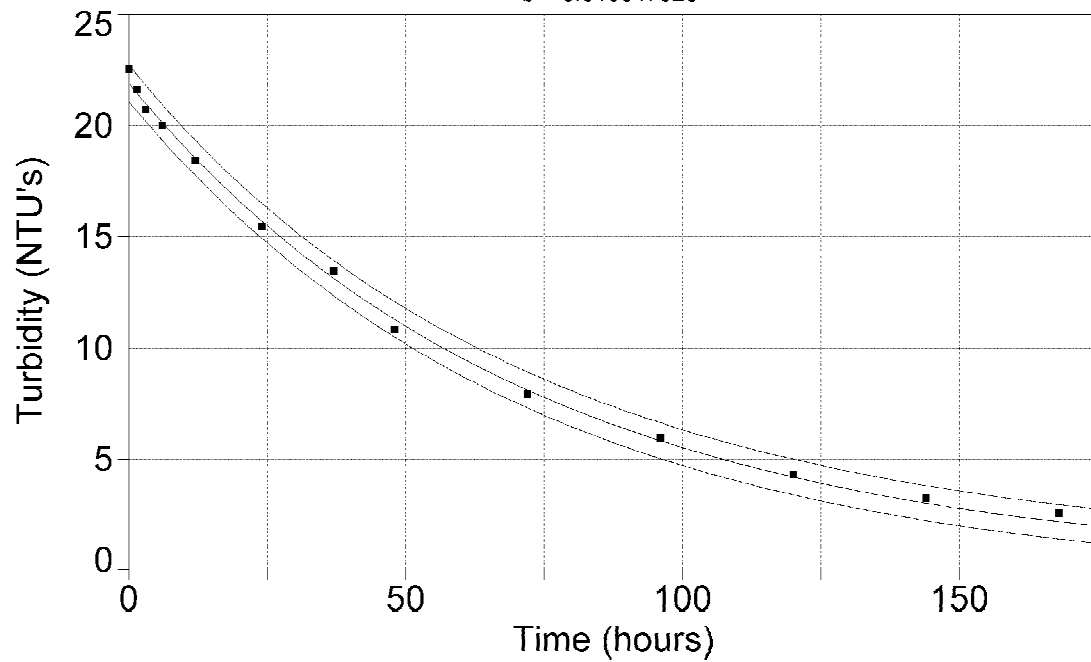
TDS 1857 High Turbidity (Replicate 2)

y = a exp(-bx)

r² = 0.99227344   DF Adj r² = 0.99072812   FitStdErr = 0.59942827   Fstat = 1412.6599

a = 20.027018

b = 0.012286781

B29
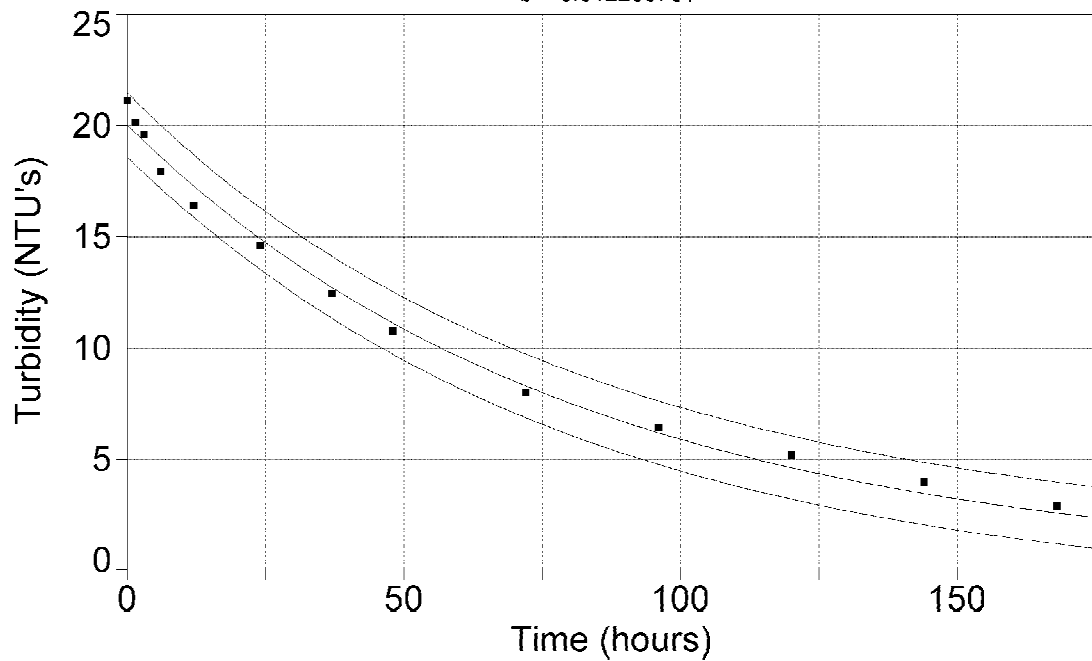
TDS 1857 High Turbidity (Average)

y = a exp(-bx)

r² = 0.99644624   DF Adj r² = 0.99573548   FitStdErr =0.43565834   Fstat = 3084.3096

a = 20.964548

b = 0.013084247
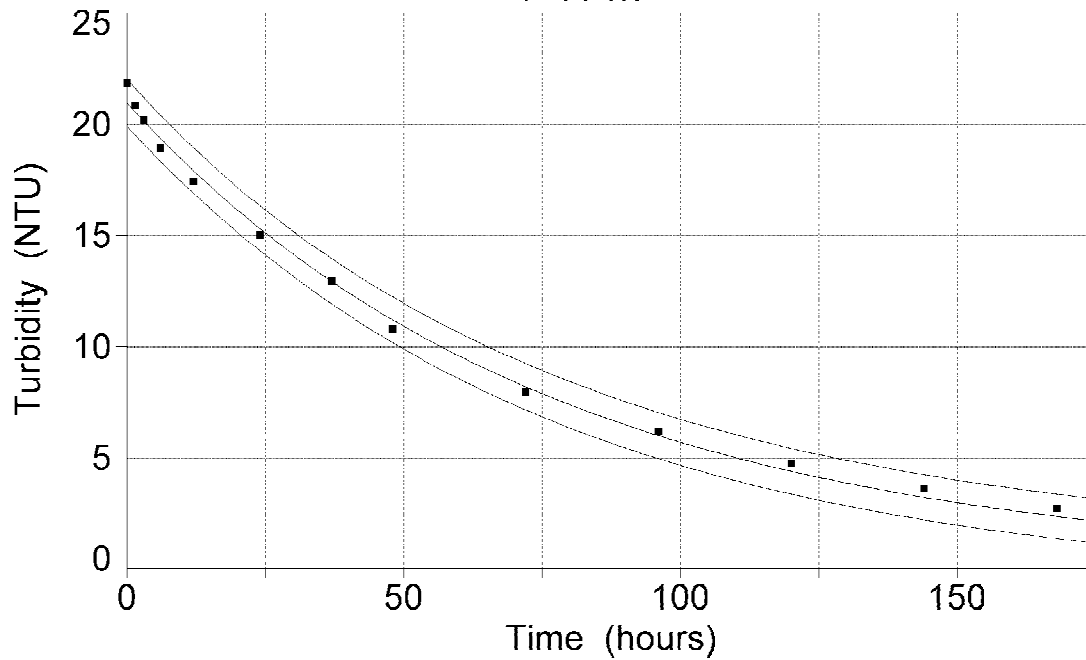
TDS 1857 Very High Turbidity

y = a exp(-bx)

r² = 0.97703692   DF Adj r² = 0.97129615   FitStdErr = 2.471732   Fstat = 382.93344

a = 41.829841

b = 0.019756677

B30
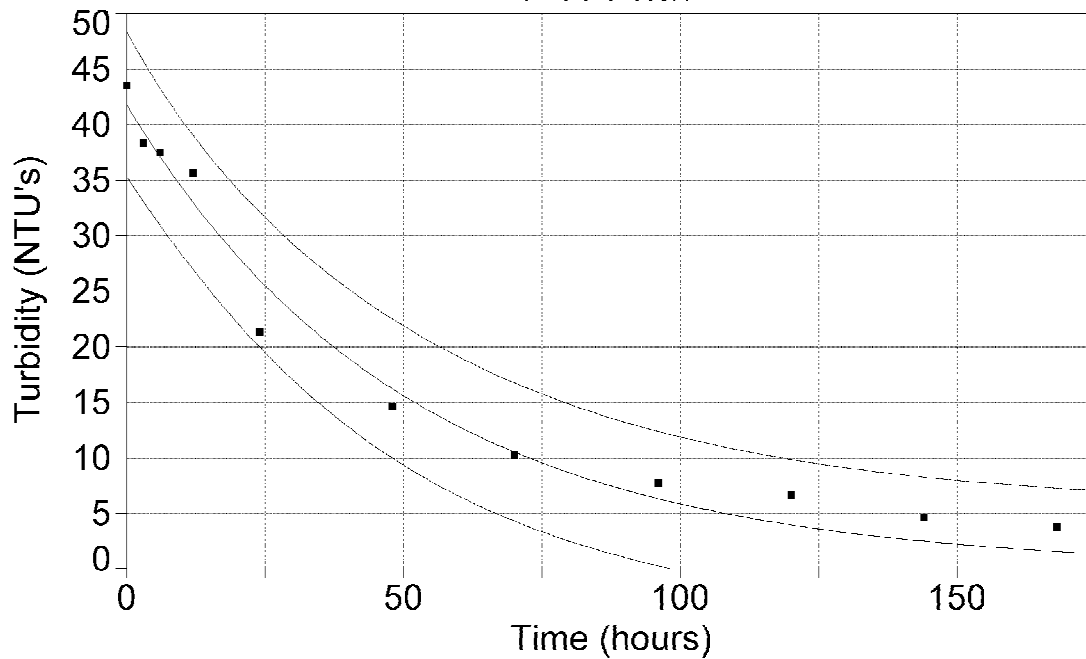
TDS 2900 Low Turbidity (Replicate 1)

y = a exp(-bx)

r² = 0.98160573   DF Adj r² = 0.97700716   FitStdErr = 0.44840606   Fstat = 480.2827

a = 8.3122605
b = 0.01819353
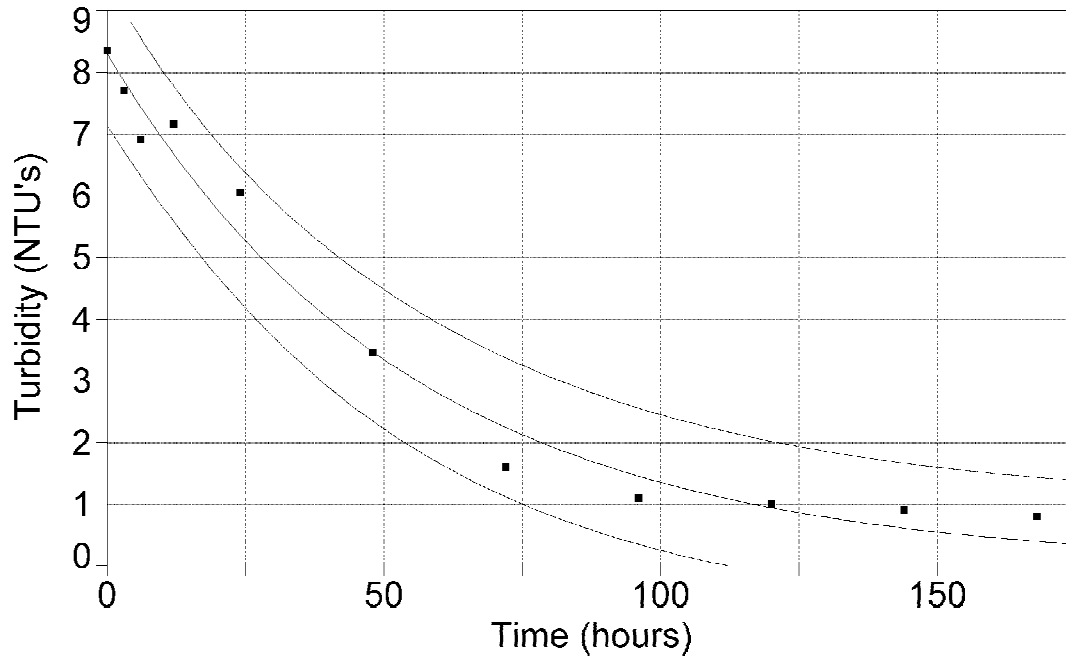
TDS 2900 Low Turbidity (Replicate 2)

y = a exp(-bx)

r² = 0.9900154   DF Adj r² = 0.98751925   FitStdErr = 0.30784246   Fstat = 892.38798

a = 8.1064513
b = 0.015341929

B31
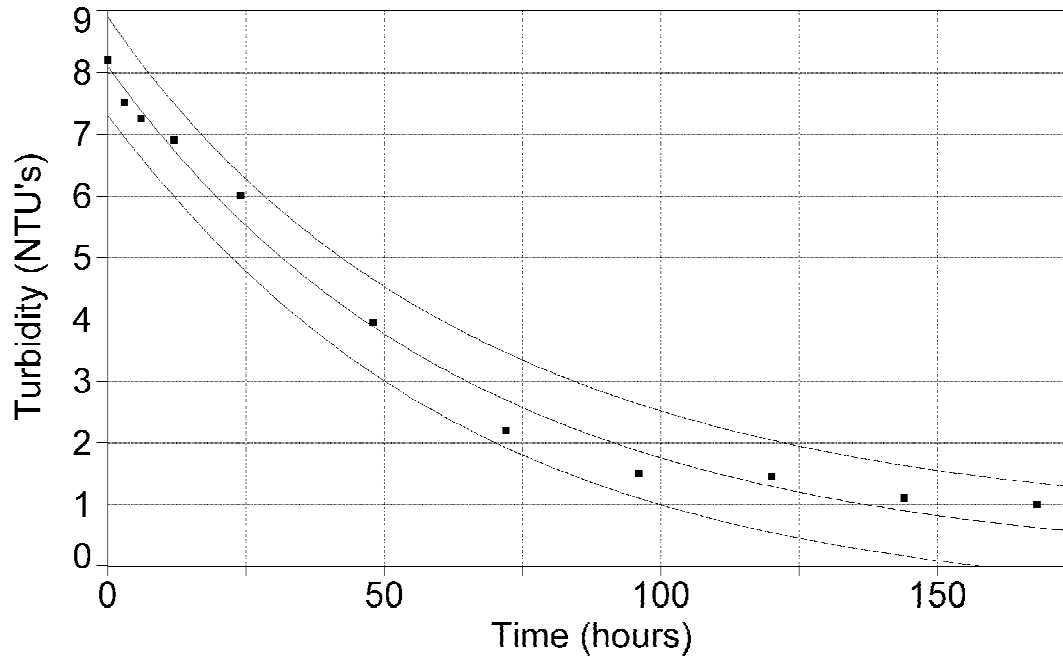
TDS 2900 Low Turbidity (Replicate 3)

y = a exp(-bx)

r² = 0.98728921   DF Adj r² = 0.98411152   FitStdErr = 0.34800593   Fstat = 699.05998

a = 8.1917852

b = 0.014887962
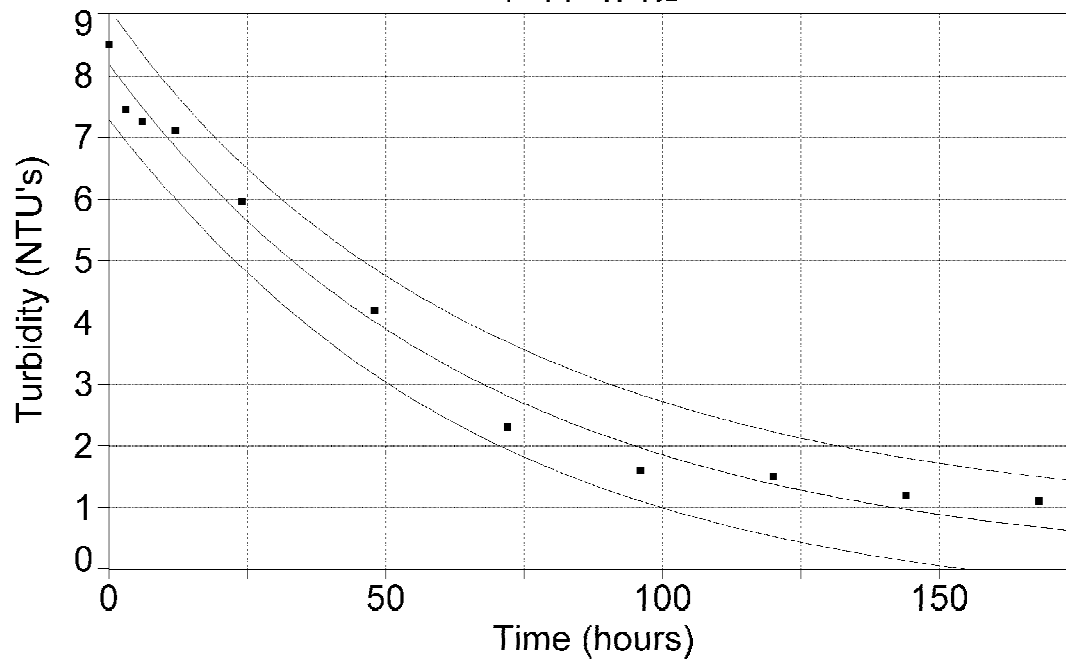
TDS 2900 Low Turbidity (Average)

y = a exp(-bx)

r² = 0.98734662   DF Adj r² = 0.98418328   FitStdErr = 0.3549591   Fstat = 702.27257

a = 8.2004913

b = 0.016076023

B32
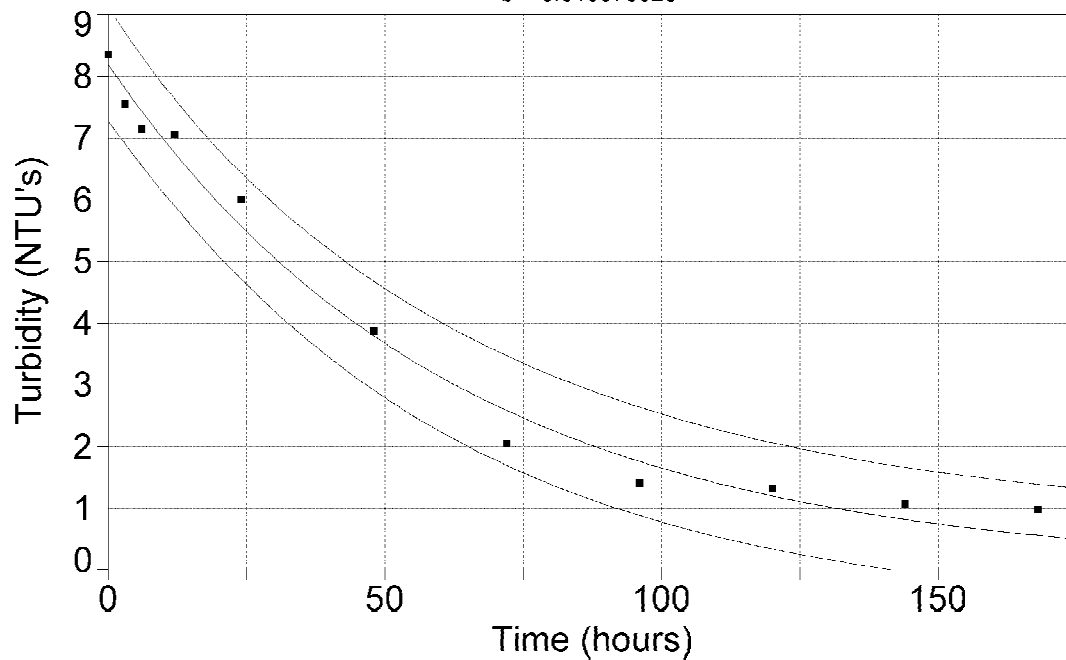
TDS 2900 High Turbidity (Replicate 1)

y = a exp(-bx)

r² = 0.98983049   DF Adj r² = 0.98728812   FitStdErr = 0.91891152   Fstat = 875.99858

a = 22.729299

b = 0.01985083
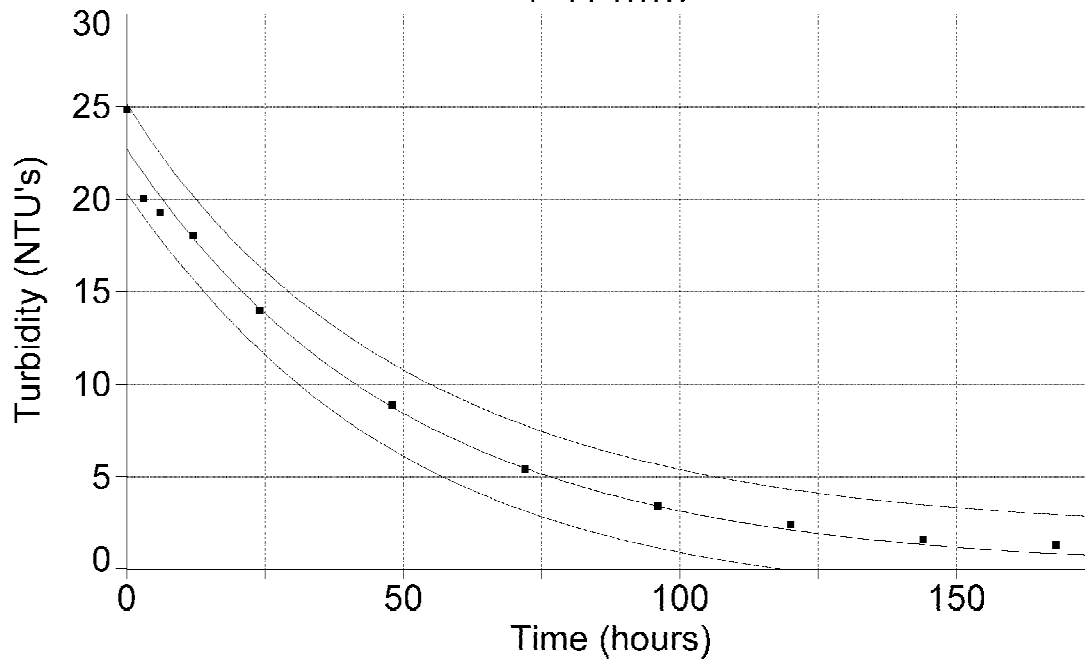
TDS 2900 High Turbidity (Replicate 2)

y = a exp(-bx)

r² = 0.97896849   DF Adj r² = 0.97371061   FitStdErr = 1.4689463   Fstat = 418.92933

a = 24.258525

b = 0.021822561

B33
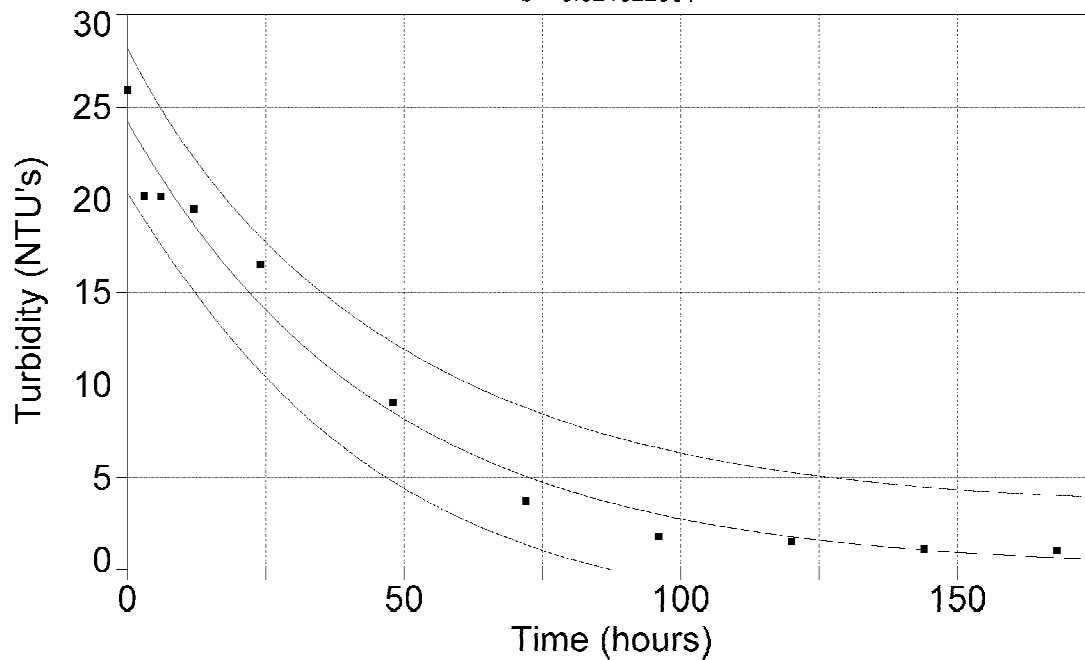
TDS 2900 High Turbidity (Average)

y = a exp(-bx)

r² = 0.98696798   DF Adj r² = 0.98370998   FitStdErr = 1.0970012   Fstat = 681.60673

a = 23.503485

b = 0.020895234
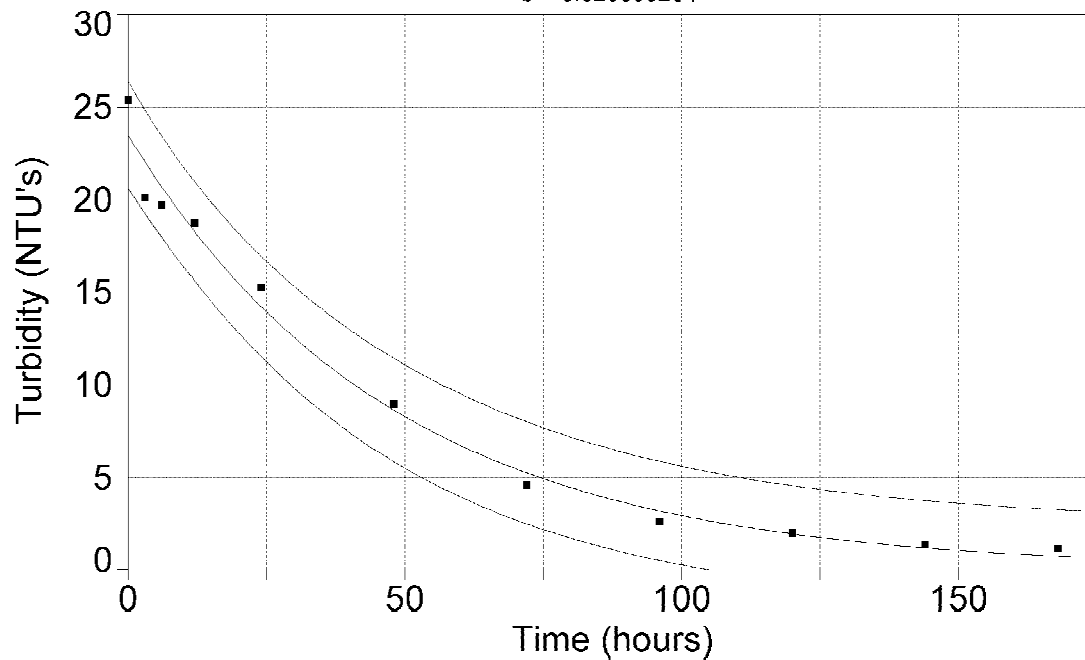
TDS 2900 Very High Turbidity

y = a exp(-bx)

r² = 0.99512919   DF Adj r² = 0.99391149   FitStdErr = 1.2682493   Fstat = 1838.7432

a = 46.118636

b = 0.064370578

B34
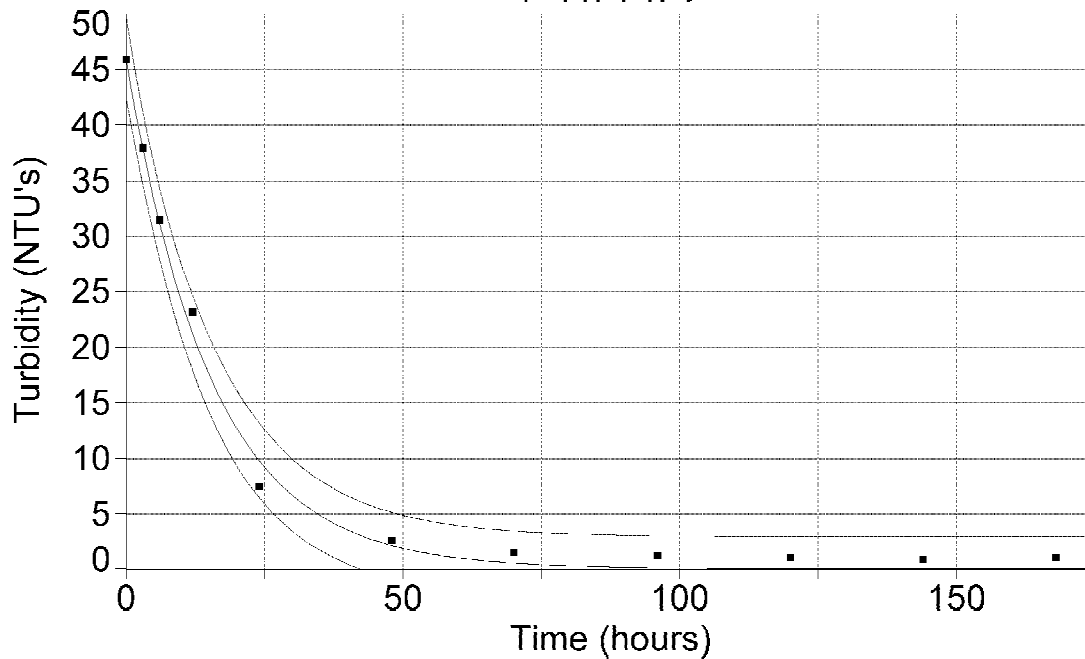
Appendix C – Results of Statistical Analyses

Anova of Variance (ANOVA) Due to Total Dissolved Solids (TDS) Concentrations, Initial Turbidity, and Replication, Based on Turbidity Decay Rate Coefficients and 7-day Turbidity Data

Ex. Hypothesis: Turbidity Decay Rate Coefficient Means are Equal (Null)
Turbidity Decay Rate Coefficient Means are Not Equal (Alternate)   or

Ex. Hypothesis: 7-day Turbidity Means are Equal (Null)
7-day Turbidity Means are Not Equal (Alternate)

    The results of analysis of variance (ANOVA) in turbidity decay rate coefficients and 7-day turbidity results due to varying total dissolved solids (TDS) concentrations, initial turbidity, and replication are presented in Tables C1 through C8. Tables C1 through C4 are results of 2-way ANOVA testing using all of the replicate data. Tables C5 through C8 are the results of 1-way ANOVA testing with replication where the TDS levels were the treatments and the averages of the three initial turbidity levels were the replicate block data. The data for 2900 mg/L TDS was excluded from the analyses in Table C7 and C8 because of an apparent outlier in that set. As such, replicate block results showed the effects of initial turbidity level. The variables are arranged in descending TDS concentration from 2900 mg/L to 600 mg/L. The results indicate that variances in the turbidity decay rate coefficients and 7-day turbidity values are not due to replication effects, but are due to changes in TDS concentrations and initial turbidity and cross-correlation between TDS level and initial turbidity level.

    Based on the results presented in Tables C1 through C8, further analyses were conducted to determine individual differences in systems due to TDS and initial turbidity changes. The results are discussed below.

Table C1. Results of ANOVA Based on Varying TDS, Turbidity, and Replication (Turbidity Decay Rate Coefficient)
Null Hypothesis: Turbidity Decay Rate Coefficient Means are Equal, Alternate: Turbidity Decay Rate Coefficient Means are Not Equal

Source of Variance	Deg. Of Freedom	Sum of Squares	$F_{*,47}$	F Ratio	Prob > F	Conclusion
TDS	7	0.00242356	2.222	687.0127	<0.0001	Rate Coefficients are Not Equal Based on TDS Changes
Turbidity	2	0.00062154	3.202	616.6600	<0.0001	Rate Coefficients are Not Equal Based on Turbidity Changes
Replicate	2	0.00000058	3.202	0.5754	0.5707	Rate Coefficients are Equal Based on Replication
TDS*Turbidity	14	0.00129243	1.919	183.1837	<0.0001	Rate Coefficients are Not Equal Based on TDS * Turbidity Changes

Table C2. Results of ANOVA Based on Varying TDS, Turbidity, and Replication
(7-Day Turbidity Level)
Null Hypothesis: 7-Day Turbidity Level Means are Equal,
Alternate: 7-Day Turbidity Level Means are Not Equal

Source of Variance	Deg. Of Freedom	Sum of Squares	$F_{*,47}$	F Ratio	Prob > F	Conclusion
TDS	7	74.313253	2.222	349.4875	<0.0001	7-Day turbidity levels are Not Equal based on TDS Changes
Turbidity	2	53.816146	3.202	885.8211	<0.0001	7-Day turbidity levels are Not Equal based on Turbidity Changes
Replicate	2	0.131302	3.202	2.1613	0.1390	7-Day turbidity levels are Equal based on Replication
TDS*Turbidity	14	19.588698	1.919	46.0618	<0.0001	7-Day turbidity levels are Not Equal based on TDS * Turbidity Changes

Table C3. Results of ANOVA Based on Varying TDS and Replication
(7-Day Turbidity Level)
Null Hypothesis: 7-Day Turbidity Level Means are Equal,
Alternate: 7-Day Turbidity Level Means are Not Equal

Source of Variance	Deg. Of Freedom	Sum of Squares	$F_{*,23\,(low)}$ $F_{*,15\,(hi)}$	F Ratio	Prob > F	Conclusion
TDS (Low Turbidity)	7	9.0812500	2.44	94.6580	<0.0001	7-Day Turbidity Levels are Not Equal Based on TDS Changes
F Ratio	2	0.0414583	3.42	1.5125	0.2543	7-Day Turbidity Levels are Equal Based on Replication
TDS (High Turbidity)	7	33.233594	2.71	70.9220	<0.0001	7-Day Turbidity Levels are Not Equal Based on TDS Changes
Replicate	1	0.097656	4.54	1.4588	0.2663	7-Day Turbidity Levels are Equal Based on Replication

Table C4. Results of ANOVA Based on Varying TDS and Replication
(Turbidity Decay Rate Coefficients)
Null Hypothesis: Turbidity Decay Rate Coefficients are Equal,
Alternate: Turbidity Decay Rate Coefficients are Not Equal

Source of Variance	Deg. Of Freedom	Sum of Squares	F *,23 (low) F *,15 (hi)	F Ratio	Prob > F	Conclusion
TDS (Low Turbidity)	7	0.00022661	2.44	70.6765	<0.0001	Rate Coefficients are Not Equal Based on TDS Changes
F Ratio	2	0.00000176	3.42	1.9177	0.1836	Rate Coefficients are Equal Based on Replication
TDS (High Turbidity)	7	0.00020883	2.71	63.8234	<0.0001	Rate Coefficients are Not Equal Based on TDS Changes
Replicate	1	0.00000023	4.54	0.4827	0.5096	Rate Coefficients are Equal Based on Replication

Table C5. Results of ANOVA Based on Varying TDS and Initial Turbidity
(Turbidity Decay Rate Coefficients)
Null Hypothesis: Turbidity Decay Rate Coefficients are Equal,
Alternate: Turbidity Decay Rate Coefficients are Not Equal

```
Routine: ANOVA1R     File: AVGK.DAT     Date: 04-17-2000
Comment: Average K (L, H & VH)

              SUM SQUARES    D. F.    MEAN SQUARE    F RATIO      SIG.
              -----------    -----    -----------    -------      ----
TREATMENT      0.0014048       7       0.0002007    2.949846    0.0403
BLOCK          0.0006741       2       0.0003370    4.953861    0.0236
ERROR          0.0009525      14       0.0000680

TOTAL          0.0030314      23


                             STANDARD      NUMBER OF
TREATMENT        MEAN         ERROR       OBSERVATIONS
---------       ------       --------     ------------
 VAR_1         0.0337828    0.0153538          3
 VAR_2         0.0140690    0.0030361          3
 VAR_3         0.0127162    0.0026474          3
 VAR_4         0.0110308    0.0021050          3
 VAR_5         0.0108847    0.0020307          3
 VAR_6         0.0107188    0.0018797          3
 VAR_7         0.0097534    0.0018741          3
 VAR_8         0.087125     0.0018768          3
```

Table C6. Results of ANOVA Based on Varying TDS and Initial Turbidity
(7-Day Turbidity Level)
Null Hypothesis: 7-Day Turbidity Level Means are Equal,
Alternate: 7-Day Turbidity Level Means are Not Equal

```
Routine: ANOVA1R       File: AVGTURB.DAT       Date: 04-17-2000
Comment: Average Final Turbidity (L, H & VH)
```

	SUM SQUARES	D. F.	MEAN SQUARE	F RATIO	SIG.
TREATMENT	44.44073	7	6.348676	7.464199	0.0008
BLOCK	39.78063	2	19.89032	23.38523	0.0000
ERROR	11.9077	14	0.8505502		
TOTAL	96.12907	23			

TREATMENT	MEAN	STANDARD ERROR	NUMBER OF OBSERVATIONS
VAR_1	1.066667	0.0666667	3
VAR_2	2.783334	0.5946521	3
VAR_3	3.333333	0.6119187	3
VAR_4	4.35	1.025102	3
VAR_5	4.183333	1.156263	3
VAR_6	4.45	1.200347	3
VAR_7	5.083334	1.431879	3
VAR_8	5.7	1.415392	3

Table C7. Results of ANOVA Based on Varying TDS and Initial Turbidity
Excluding 2900 mg/L TDS Data (Turbidity Decay Rate Coefficients)
Null Hypothesis: Turbidity Decay Rate Coefficients are Equal,
Alternate: Turbidity Decay Rate Coefficients are Not Equal

```
Routine: ANOVA1R       File: AVGK3.DAT       Date: 04-17-2000
Comment: Effect of Initial Turbidity on K without 2900 mg/L TDS
```

	SUM SQUARES	D. F.	MEAN SQUARE	F RATIO	SIG.
TREATMENT	0.0001981	2	0.0000990	84.53246	0.0000
BLOCK	0.0000574	6	0.0000096	2.949853	0.0011
ERROR	0.0000141	12	0.0000012		
TOTAL	0.0002695	20			

TREATMENT	MEAN	STANDARD ERROR	NUMBER OF OBSERVATIONS
VAR_1	0.0074704	0.0004818	7
VAR_2	0.0109243	0.0006628	7
VAR_3	0.0149847	0.0010147	7

Table C8. Results of ANOVA Based on Varying TDS and Initial Turbidity
Excluding 2900 mg/L TDS Data (7-Day Turbidity Level)
Null Hypothesis: 7-Day Turbidity Level Means are Equal,
Alternate: 7-Day Turbidity Level Means are Not Equal

```
Routine: ANOVA1R       File: AVGTURB3.DAT       Date: 04-17-2000
Comment: Effect of Initial NTU on Final NTU without 2900 mg/L TDS

            SUM SQUARES    D. F.    MEAN SQUARE    F RATIO      SIG.
            -----------    -----    -----------    -------      ----
TREATMENT    45.40167        2       22.70083      43.51599    0.0000
BLOCK        17.52071        6       2.920119      5.597674    0.0056
ERROR        6.259998       12       0.5216665

TOTAL        69.18238       20


                            STANDARD      NUMBER OF
TREATMENT       MEAN          ERROR      OBSERVATIONS
---------      ------       --------     ------------
 VAR_1         2.4          0.1745743        7
 VAR_2         4.414286     0.3984664        7
 VAR_3         5.992858     0.6139672        7
```

Evaluation of Turbidity Decay Rate Coefficients Based on Varying TDS Levels Without Consideration of Initial Turbidity

Ex. Hypothesis:

      1857 mg/l TDS decay rate – 1050 mg/l TDS decay rate = 0   (Null)

      1857 mg/l TDS decay rate – 1050 mg/l TDS decay rate > 0   (Alternate)

    Duncan's Multiple Range Test was used to compare the turbidity decay rate coefficients (means for the three initial turbidity levels) at a given TDS concentration level with the turbidity decay rate coefficients (means for the three initial turbidity levels) at any other TDS concentration level. All possible pairs are compared at a significance of 0.05 and 0.01 to show differences with confidence levels of 95 and 99 percent.   The results are shown in Table C9. GROUP1 is the data for 2900 mg/L TDS, GROUP2 for 1857 mg/L TDS, GROUP3 for 1592 mg/L, GROUP4 for 1320 mg/L, GROUP5 for 1050 mg/L, GROUP6 for 900 mg/L, GROUP7 for 750 mg/L, and GROUP8 for 600 mg/L. Without considering initial turbidity, only GROUP1 (2900 mg/L) was different from the others. This shows that the effects of initial turbidity can overwhelm the effects of TDS concentration.

Table C9. Comparisons of Turbidity Decay Rate Coefficients for Varying TDS Without Explicitly Considering Initial Turbidity Effects

```
Routine: MRANGE        File: AVGK.MRT       Date: 04-17-2000
Comment: Average K (L, H & VH)

Treatment          Mean          Duncan's Multiple-Range Test
---------          -------
 GROUP8          0.0087125
 GROUP7          0.0097534
 GROUP6          0.0107188
 GROUP5          0.0108847
 GROUP4          0.0110308
 GROUP3          0.0127161
 GROUP2          0.0140690
 GROUP1          0.0337828

Standard Error of Treatment Means =  0.0047621
```

Treatment	vs.	Treatment	Difference	Sig .05	Sig .01
GROUP8		GROUP7	0.0010409	-	-
GROUP8		GROUP6	0.0020063	-	-
GROUP8		GROUP5	0.0021722	-	-
GROUP8		GROUP4	0.0023183	-	-
GROUP8		GROUP3	0.0040036	-	-
GROUP8		GROUP2	0.0053564	-	-
GROUP8		GROUP1	0.0250703	*	*
GROUP7		GROUP6	0.0009654	-	-
GROUP7		GROUP5	0.0011313	-	-
GROUP7		GROUP4	0.0012774	-	-
GROUP7		GROUP3	0.0029628	-	-
GROUP7		GROUP2	0.0043156	-	-
GROUP7		GROUP1	0.0240294	*	*
GROUP6		GROUP5	0.0001659	-	-
GROUP6		GROUP4	0.0003120	-	-
GROUP6		GROUP3	0.0019973	-	-
GROUP6		GROUP2	0.0033502	-	-
CROUP6		GROUP1	0.0230640	*	*
GROUP5		GROUP4	0.0001461	-	*
GROUP5		GROUP3	0.0018315	-	-
GROUP5		GROUP2	0.0031843	-	-
GROUP5		GROUP1	0.0228981	*	*
GROUP4		GROUP3	0.0016853	-	-
GROUP4		GROUP2	0.0030381	-	-
GROUP4		GROUP1	0.0227520	*	*
GROUP3		GROUP2	0.0013528	-	-
GROUP3		GROUP1	0.0210667	*	*
GROUP2		GROUP1	0.0197138	*	-

* shows significant difference

Evaluation of 7-Day Turbidities Based on Varying TDS Levels Without Consideration of Initial Turbidity

Ex. Hypothesis:
   1857 mg/l TDS 7-day turbidity – 900 mg/l TDS 7-day turbidity = 0   (Null)
   1857 mg/l TDS 7-day turbidity – 900 mg/l TDS 7-day turbidity > 0 (Alternate)

   Duncan's Multiple Range Test was used to compare the 7-day turbidities (mean for initial turbidities of 8, 24, and 43 NTU) at a given TDS concentration and the 7-day turbidities (mean for initial turbidities of 8, 24, and 43 NTU) at any other TDS concentration. All possible pairs are compared at a significance of 0.05 and 0.01 to show differences with confidence levels of 95 and 99 percent. Table C10 shows the results of the comparisons. GROUP1 is the data for 2900 mg/L TDS, GROUP2 for 1857 mg/L TDS, GROUP3 for 1592 mg/L, GROUP4 for 1320 mg/L, GROUP5 for 1050 mg/L, GROUP6 for 900 mg/L, GROUP7 for 750 mg/L, and GROUP8 for 600 mg/L. Without considering initial turbidity, only GROUP1 (2900 mg/L) was different from all of the others. GROUP2 was different from GROUP7 and GROUP8. GROUP3 was different from GROUP8. This shows that the effects of initial turbidity can overwhelm the effects of TDS concentration.

Evaluation of Turbidity Decay Rate Coefficients Based on Varying Initial Turbidity Without Consideration of TDS Levels

Ex. Hypothesis:
   High Initial Turbidity decay rate – Low Initial Turbidity decay rate = 0   (Null)
   High Initial Turbidity decay rate – Low Initial Turbidity decay rate > 0   (Alternate)

   Duncan's Multiple Range Test was used to compare the turbidity decay rate coefficients (means of the replicates) at a given initial turbidity level with the turbidity decay rate coefficients (means of the replicates) at any other initial turbidity level. All possible pairs are compared at a significance of 0.05 and 0.01 to show differences with confidence levels of 95 and 99 percent.   The results are shown in Table C11 and C12 (without the 2900 mg/L TDS data). GROUP1 is the data for low initial turbidity (8 NTU), GROUP2 for high initial turbidity (24 NTU), and GROUP3 for very high initial turbidity (43 NTU). Without considering TDS level, the rates for very high initial turbidity were significantly different from the others, but the rates for high initial turbidity were not significantly different from the rates for low initial turbidity. If the data for the 2900 mg/L TDS level were excluded, the rates for all three initial turbidity levels were significantly different from each other. This shows that the effects of initial turbidity can overwhelm the effects of TDS concentration.

Table C10. Comparisons of 7-day Turbidity for Varying TDS Without Explicitly Considering Initial Turbidity Effects

```
Routine: MRANGE        File: AVGTURB.MRT       Date: 04-17-2000
Comment: Average Final Turbidity (L, H & VH)

Treatment          Mean          Duncan's Multiple-Range Test
---------          -------
 GROUP1            1.066667
 GROUP2            2.783334
 GROUP3            3.333333
 GROUP5            4.183333
 GROUP4            4.35
 GROUP6            4.45
 GROUP7            5.083334
 GROUP8            5.7

Standard Error of Treatment Means =  0.5324629

Treatment  vs.  Treatment       Difference      Sig .05     Sig .01
---------       ---------       ----------      -------     -------
 GROUP1          GROUP2         1.716667           *           -
 GROUP1          GROUP3         2.266666           *           -
 GROUP1          GROUP5         3.116666           *           *
 GROUP1          GROUP4         3.283333           *           *
 GROUP1          GROUP6         3.383333           *           *
 GROUP1          GROUP7         4.016667           *           *
 GROUP1          GROUP8         4.633333           *           *
 GROUP2          GROUP3         0.549999           -           -
 GROUP2          GROUP5         1.399999           -           -
 GROUP2          GROUP4         1.566666           -           -
 GROUP2          GROUP6         1.666666           -           -
 GROUP2          GROUP7         2.3                *           -
 GROUP2          GROUP8         2.916666           *           *
 GROUP3          GROUP5         0.8499999          -           -
 GROUP3          GROUP4         1.016667           -           -
 GROUP3          GROUP6         1.116667           -           -
 GROUP3          GROUP7         1.7S0001           -           -
 GROUP3          GROUP8         2.366667           *           -
 GROUP5          GROUP4         0.166667           -           -
 GROUP5          GROUP6         0.2666669          -           -
 GROUP5          GROUP7         0.9000011          -           -
 GROUP5          GROUP8         1.S16667           -           -
 GROUP4          GROUP6         0.0999999          -           -
 GROUP4          GROUP7         0.7333341          -           -
 GROUP4          GROUP8         1.35               -           -
 GROUP6          GROUP7         0.6333342          -           -
 GROUP6          GROUP8         1.25               -           -
 GROUP7          GROUP8         0.6166658          -           -
```

* shows significant difference

**Table C11. Comparisons of Turbidity Decay Rate Coefficients for Varying Initial
Turbidity Without Explicitly Considering TDS Effects**

```
Routine: MRANGE        File: AVGK2.MRT      Date: 04-17-2000
Comment: Effect of Initial Turbidity on K

Treatment          Mean          Duncan's Multiple-Range Test
---------          -------
 GROUP1          0.0085543
 GROUP2          0.0121634
 GROUP3          0.021158


Standard Error of Treatment Means =  0.0029162

Treatment  vs.  Treatment      Difference     Sig .05    Sig .01
---------       ---------      ----------    -------    -------
 GROUP1          GROUP2         0.0036091        -          -
 GROUP1          GROUP3         0.0126038        *          -
 GROUP2          GROUP3         0.0089946        *          -
```


**Table C12. Comparisons of Turbidity Decay Rate Coefficients for Varying Initial
Turbidity Without Explicitly Considering TDS Effects
(Excluding 2900 mg/L TDS Data)**

```
Routine: MRANGE        File: AVGK3.MRT      Date: 04-17-2000
Comment: Effect of Initial Turbidity on K without 2900 mg/L TDS

Treatment          Mean          Duncan's Multiple-Range Test
---------          -------
 GROUP1          0.0074704
 GROUP2          0.0109243
 GROUP3          0.0149847


Standard Error of Treatment Means =  0.00040909

Treatment  vs.  Treatment      Difference     Sig .05    Sig .01
---------       ---------      ----------    -------    -------
 GROUP1          GROUP2         0.0034539        *          *
 GROUP1          GROUP3         0.0075143        *          *
 GROUP2          GROUP3         0.0040604        *          *
```


Evaluation of 7-day Turbidities Based on Varying Initial Turbidity Without Consideration of TDS Levels

Ex. Hypothesis:
   High Initial Turbidity 7-day NTU – Low Initial Turbidity 7-day NTU = 0   (Null)
   High Initial Turbidity 7-day NTU – Low Initial Turbidity 7-day NTU > 0 (Alternate)

   Duncan's Multiple Range Test was used to compare the 7-day turbidities (means of
the replicates) at a given initial turbidity level with the 7-day turbidities (means of the

replicates) at any other initial turbidity level. All possible pairs are compared at a significance of 0.05 and 0.01 to show differences with confidence levels of 95 and 99 percent.   The results are shown in Table C13 and C14 (without the 2900 mg/L TDS data). GROUP1 is the data for low initial turbidity (8 NTU), GROUP2 for high initial turbidity (24 NTU), and GROUP3 for very high initial turbidity (43 NTU). Without considering TDS level, the 7-day turbidities for all three initial turbidity levels were significantly different from each other. This shows that the effects of initial turbidity can overwhelm the effects of TDS concentration.

Table C13. Comparisons of 7-day Turbidities for Varying Initial Turbidity Without Explicitly Considering TDS Effects

```
Routine: MRANGE        File: AVGTURB2.MRT      Date: 04-17-2000
Comment: Effect of Initial Turbidity on Final Turbidity

Treatment          Mean          Duncan's Multiple-Range Test
---------          -------
 GROUP1            2.225
 GROUP2            4.0125
 GROUP3            5.36875

Standard Error of Treatment Means =   0.3260656

Treatment   vs.   Treatment      Difference     Sig .05     Sig .01
---------         ---------      ----------     -------     -------
 GROUP1            GROUP2          1.7875           *           *
 GROUP1            GROUP3          3.14375          *           *
 GROUP2            GROUP3          1.35625          *           -
```

Table C14. Comparisons of 7-day Turbidities for Varying Initial Turbidity Without Explicitly Considering TDS Effects (Excluding 2900 mg/L TDS Data)

```
Routine: MRANGE        File: AVGTURB3.MRT      Date: 04-17-2000
Comment: Effect of Initial NTU on Final NTU without 2900 mg/L TDS

Treatment          Mean          Duncan's Multiple-Range Test
---------          -------
 GROUP1            2.4
 GROUP2            4.414286
 GROUP3            5.992858

Standard Error of Treatment Means =   0.2729905

Treatment   vs.   Treatment      Difference     Sig .05     Sig .01
---------         ---------      ----------     -------     -------
 GROUP1            GROUP2          2.014286         *           *
 GROUP1            GROUP3          3.592858         *           *
 GROUP2            GROUP3          1.578572         *           -
```

C10

Evaluation of the Effect of Low, High, and Very High Initial Turbidity at Varying TDS Levels on Turbidity Decay Rate Coefficients

Ex. Hypothesis:

Rates at High Turbidity - Rates at Very High Turbidity = 0   (Null)

Rates at High Turbidity - Rates at Very High Turbidity > 0   (Alternate)

The Student's paired t-test results of comparison of mean low, high, and very high initial turbidity levels on turbidity decay rate coefficients at seven TDS levels are presented in Table C15. The 2900 mg/l TDS level was excluded in order to assess whether the variance associated with the 2900 mg/l TDS level was so high that it masked differences between the high and very high initial turbidity sedimentation rate coefficients. The comparisons presented in Table C16 indicate that there is significant evidence to suggest a difference between sedimentation rate coefficients at the three initial turbidity levels.

The Student's paired t-test results of comparison of low, high, and very high initial turbidity levels on turbidity decay rate coefficients at eight TDS levels are presented in Table C16. The results show significant evidence of a difference in sedimentation rate coefficients between low and high initial turbidity levels and between low and very high initial turbidity levels. However, the data do not show evidence of a difference between turbidity decay rates at high and very high initial turbidity levels. Between replicates, i.e., the (3) replicates at low turbidity and the (2) replicates at high turbidity, there is not significant evidence of a difference between the turbidity decay rates at the same initial turbidity and TDS level. Hence, differences in turbidity decay rates are likely due to changes in initial turbidity levels as opposed to differences associated with replication.

Table C15. Evaluation of Sedimentation Rate Coefficients for Varying TDS Levels (2900 mg/l TDS Data Excluded) and Varying Initial Turbidity Levels *

Turbidity Level 1 vs.	Turbidity Level 2	Ref. $F_{7,7}$ statist.	Calculated F ratio	Ref. t $_{0.05}$	Calculated t statistic	Conclusion
Paired t, High Avg. turb., 7 TDS levels	Very High turb., 7 TDS levels	4.28	12.3138	1.943, DF = 7, t $_{0.05}$	2.797969, p<t=0.984	**There is significant evidence to suggest there is a difference, r^2=0.711**
Low Avg.	High Avg.	4.28	3.9629	1.943	7.021638 p<t=0.999	**There is significant evidence to suggest there is a difference, r^2=0.442**
Low Avg.	Very High	4.28	27.2343	1.943	5.514658 p<t=0.999	**There is significant evidence to suggest there is a difference, r^2=0.845**

Table C16. Evaluation of Sedimentation Rate Coefficients for Varying TDS Levels at Low (8NTU), High (24NTU) and Very High (43NTU) Initial Turbidity Levels *

Turbidity Level 1 vs.	Turbidity Level 2	Ref. $F_{7,7}$ statist.	Calculated F ratio	Ref. t $_{0.05}$	Calculated t statistic	Conclusion
Paired t, High Avg. tur, 8 TDS levels	Very High tur., 8 TDS levels	3.79	76.8135	1.895, DF = 7, t $_{0.05}$	1.597133, p<t=0.923	Not significant evidence to suggest there is a difference, r^2=0.928
Paired t, High Avg. tur, 7 TDS levels	Very High tur., 7 TDS levels	4.28	12.3138	1.943, DF = 7, t $_{0.05}$	2.797969, p<t=0.984	**There is significant evidence to suggest there is a difference, r^2=0.711**
Low Avg.	High Avg.	3.79	53.1931	1.895	8.083524 p<t=1.000	**There is significant evidence to suggest there is a difference, r^2=0.899**
Low Avg.	High Avg.	4.28	3.9629	1.943	7.021638 p<t=0.999	**There is significant evidence to suggest there is a difference, r^2=0.442**
Low Avg.	Very High	3.79	193.0140	1.895	2.241339 p<t=0.970	**There is significant evidence to suggest there is a difference, r^2=0.970**
Low Avg.	Very High	4.28	27.2343	1.943	5.514658 p<t=0.999	**There is significant evidence to suggest there is a difference, r^2=0.845**
Rep 1 Low	Rep 2 Low	3.79	130.7672	1.895	1.572752 p<t=0.920	Not significant evidence to suggest there is a difference, r^2=0.956
Rep 1 Low	Rep 3 Low	3.79	221.894	1.895	1.321571 p<t=0.886	Not significant evidence to suggest there is a difference, r^2=0.974
Rep 2 Low	Rep 3 Low	3.79	307.5973	1.895	0.330615 p<t=0.625	Not significant evidence to suggest there is a difference, r^2=0.981
Rep 1 High	Rep 2 High	3.79	121.8500	1.895	0.69476 p<t=0.745	Not significant evidence to suggest there is a difference, r^2=0.953

Evaluation of the Effect of Low, High, and Very High Initial Turbidity at Varying TDS Levels on Turbidity Decay Rate Coefficients Using Replicate Data

Ex. Hypothesis:
   1857 (3 low, 2 high, 1 very high) – 1592 (3 low, 2 high, 1 very high) = 0 (Null)
   1857 (3 low, 2 high, 1 very high) – 1592 (3 low, 2 high, 1 very high) < 0 (Alternate)

   The results of the evaluation of the effect of varying initial turbidity levels and TDS levels on turbidity decay rate coefficients using Student's paired-t tests are presented in Table C17. Table C17 presents comparisons among the turbidity decay rates at 2900 mg/L TDS level, 1857 mg/L TDS level and each of the other TDS levels considering differences in initial turbidity levels. When replicates are compared, without averaging, the statistical data indicate differences between 1857 mg/l TDS and 2900 mg/l TDS and all other TDS levels.

Evaluation of the Effect of Low, High, and Very High Initial Turbidity at Varying TDS Levels on 7-Day Turbidity Using Replicate Data

Ex. Hypothesis:
   1857 (3 low, 2 high, 1 very high) – 1592 (3 low, 2 high, 1 very high) = 0 (Null)
   1857 (3 low, 2 high, 1 very high) – 1592 (3 low, 2 high, 1 very high) < 0 (Alternate)

   The results of comparison of the 7-day turbidities at each of the TDS levels to the 7-day turbidities at both the 1857 and 2900 mg/l TDS using a paired-t test that paired replicates of like initial turbidity levels are presented in Table C18. The results indicate there is a significant difference between 7-day turbidities at TDS of 1857 and 2900 mg/l and at 1857 and 900 mg/l for very high, high, and low initial turbidity levels. The remaining comparisons of turbidities at 1857 mg/l TDS to turbidities at 1592, 1320, 1050, 750, and 600 mg/l TDS showed no significant difference. The results of comparison of 7-day turbidities at each TDS level to turbidities at 2900 mg/l TDS indicate there are significant differences at each TDS level.

Table C17. Evaluation of the Effects of Altering TDS Levels from 2900 mg/l and 1857 mg/l TDS for Low, High, and Very High Initial Turbidity Levels on Sedimentation Rate Coefficients Using Replicate Data

k at TDS 1 vs.	k at TDS 2	Ref. $F_{5,5}$ statist.	Calculated F ratio	Ref. $t_{0.05}$	Calculated t statistic	Conclusion
1857 k, (6) reps, paired t	2900 k, (6) reps	5.05	25.5922	2.015	2.135826 (p<t=0.957)	**There is significant evidence to suggest there is a difference, r^2=0.864829**
1857	1592	5.05	55.5225	2.015	2.631054 (p<t=0.977)	**There is significant evidence to suggest there is a difference, r^2=0.932798**
1857	1320	5.05	47.6544	2.015	3.61556 (p<t=0.992)	**There is significant evidence to suggest there is a difference, r^2=0.922562**
1857	1050	5.05	18.2402	2.015	3.463881 (p<t=0.991)	**There is significant evidence to suggest there is a difference, r^2=0.820145**
1857	900	5.05	115.1549	2.015	3.908966 (p<t=0.994)	**There is significant evidence to suggest there is a difference, r^2=0.96643**
1857	750	5.05	22.3822	2.015	4.829693 (p<t=0.998)	**There is significant evidence to suggest there is a difference, r^2=0.848382**
1857	600	5.05	0.1871	2.015	3.482048 (p<t=0.991)	**There is significant evidence to suggest there is a difference, r^2=0.44679**
2900 k, (6) reps, paired t	1592 k, (6) reps	5.05	9.4879	2.015	2.221801 (p<t=0.962)	**There is significant evidence to suggest there is a difference, r^2=0.703437**
2900	1320	5.05	68.1808	2.015	2.358196 (p<t=0.968)	**There is significant evidence to suggest there is a difference, r^2=0.944584**
2900	1050	5.05	4.7029	2.015	2.312116 (p<t=0.966)	**There is significant evidence to suggest there is a difference, r^2=0.540382**
2900	900	5.05	33.0640	2.015	2.353489 (p<t=0.967)	**There is significant evidence to suggest there is a difference, r^2=0.892079**
2900	750	5.05	5.7862	2.015	2.453534 (p<t=0.971)	**There is significant evidence to suggest there is a difference, r^2=0.59126**
2900	600	5.05	0.0556	2.015	2.427011 (p<t=0.970)	**There is significant evidence to suggest there is a difference, r^2=0.013712**

Table C18. Evaluation of the Effects of Altering TDS Levels from
2900 mg/l and 1857 mg/l TDS for Low, High, and Very High Initial Turbidity Levels
on 7-Day Turbidity Levels Using Replicate Data

7-day Turbidity 1	7-day Turbidity 2	Ref. $F_{5,5}$ statist.	Calculated F ratio	Ref. $t_{0.05}$	Calculated t statistic	Conclusion
1857 (7) day tur., (6) reps, paired t	2900 (7) day tur., (6) reps	5.05	19876.84	2.015	2.68527 p<t=0.978	**There is significant evidence to suggest there is a difference,** r^2=0.9998
1857	1592	5.05	9613.251	2.015	1.677255 p<t=0.923	Not significant evidence to suggest there is a difference, r^2=0.9996
1857	1320	5.05	19598.12	2.015	1.579515 p<t=0.913	Not significant evidence to suggest there is a difference, r^2=0.9998
1857	1050	5.05	5671.479	2.015	1.97506 p<t=0.947	Not significant evidence to suggest there is a difference, r^2=0.9993
1857	900	5.05	6390.34	2.015	2.037318 p<t=0.951	**There is significant evidence to suggest there is a difference,** r^2=0.9994
1857	750	5.05	4039.179	2.015	0.580763 p<t=0.707	Not significant evidence to suggest there is a difference, r^2=0.9990
1857	600	5.05	33695.35	2.015	1 p<t=0.818	Not significant evidence to suggest there is a difference, r^2=0.9999
2900 (7) day tur., (6) reps, paired t	1592 (7) day tur., (6) reps	5.05	11357.07	2.015	2.053282 p<t=0.952	**There is significant evidence to suggest there is a difference,** r^2=0.9996
2900	1320	5.05	7957.878	2.015	2.788749 p<t=0.981	**There is significant evidence to suggest there is a difference,** r^2=0.9995
2900	1050	5.05	3720.971	2.015	2.321884 p<t=0.966	**There is significant evidence to suggest there is a difference,** r^2=0.9989
2900	900	5.05	2978.975	2.015	-2.52037 p<t=0.027	**There is significant evidence to suggest there is a difference,** r^2=0.9987
2900	750	5.05	6627.787	2.015	2.319529 p<t=0.966	**There is significant evidence to suggest there is a difference,** r^2=0.9994
2900	600	5.05	8931.812	2.015	3.010643 p<t=0.985	**There is significant evidence to suggest there is a difference,** r^2=0.9996

Evaluation of Turbidity Decay Rate Coefficients Based on Varying Initial Turbidity and TDS Levels

Ex. Hypothesis:
   1857 mg/l TDS rate (3 low) – 1050 mg/l TDS rate (3 low) = 0 (Null)
   1857 mg/l TDS rate (3 low) – 1050 mg/l TDS rate (3 low) > 0 (Alternate)

   The results of comparison of turbidity decay rate coefficients at each of the TDS levels to turbidity decay rate coefficients at each of the other TDS levels using Duncan's multiple range test are presented in Table C19 for the three low initial turbidity replicates. The same comparisons were performed for the two high initial turbidity replicates and are also presented in Table C20. GROUP1 is the data for 2900 mg/L TDS, GROUP2 for 1857 mg/L TDS, GROUP3 for 1592 mg/L, GROUP4 for 1320 mg/L, GROUP5 for 1050 mg/L, GROUP6 for 900 mg/L, GROUP7 for 750 mg/L, and GROUP8 for 600 mg/L. Comparisons of the low initial turbidity results were also made using Student's paired t-tests and these results are presented in Table C21. Results of the comparisons of the turbidity decay rates for the high initial turbidity level using Student's paired t-tests are also presented in Table C21.

   The results of the Duncan's multiple range test show that rates at 600, 1857 and 2900 mg/L TDS for low initial turbidity are generally significantly different from the rates at all other TDS levels. Rates for TDS concentrations more than about 850 mg/L apart are significantly different. The significance of the difference between rates at TDS concentrations less than 850 mg/L apart is inconsistent. The results of the Duncan's multiple range test for high initial turbidity are consistent with the results at low initial turbidity.

   The results of the comparisons at the three low initial turbidity levels indicate significant differences between 2900, 750, and 600 mg/L TDS and all other TDS levels. However, the statistical data indicate no difference between 1857 and 1320 mg/L TDS, 1592 and 1320 mg/L TDS, 1592 and 900 mg/L TDS, 1320 and 1050 mg/L TDS, and 1320 and 900 mg/L TDS. At the low initial turbidity level (8 NTU) the significance of differences in the turbidity decay rates were inconsistent at TDS levels ranging from 900 to 1857 mg/L TDS. When TDS levels are greater than 1857 mg/L or less than 900 mg/L, there was significant evidence of a difference in each case.

   The results of the comparison using paired-t tests at the two high initial turbidity levels indicate no difference between 1857 mg/l TDS and any of the other initial TDS concentrations, including 2900 mg/l TDS, on turbidity decay rate coefficients. However, comparisons of all other TDS levels yielded differences, with only three exceptions; 1592 and 1050 mg/l TDS (no difference), 1320 and 900 mg/l TDS (no difference), and 1320 and 750 mg/l TDS (no difference). Similarly to the results of the paired-t tests conducted on the three low replicates described above, there appears to be a range of TDS levels that may not result in significant differences in turbidity decay rate coefficients. In the case of high initial turbidity levels, that range begins at approximately 600 – 750 mg/l

TDS to 1857 mg/l TDS. When TDS levels are greater than 1857 mg/l, i.e., 2900 mg/l, and less than 750 mg/l, i.e., 600 mg/l, there was significant evidence of a difference in each case with the exception of 2900 and 1857 mg/l comparisons (no difference).

Table C19. Comparisons Between Turbidity Decay Rates at Low Initial Turbidity as a Function of TDS Levels Using Replicate Data

```
Routine: MRANGE        File: LOWK.MRT      Date: 04-17-2000
Comment: Low K

Treatment          Mean         Duncan's Multiple-Range Test
---------         -------
 GROUP8          0.0056377
 GROUP7          0.0062297
 GROUP5          0.0069932
 GROUP6          0.0078294
 GROUP3          0.0080071
 GROUP4          0.0082133
 GROUP2          0.0093833
 GROUP1          0.0161411


Standard Error of Treatment Means =  0.00039066


Treatment   vs.   Treatment      Difference     Sig .05      Sig .01
---------         ---------      ----------     -------      -------
 GROUP8            GROUP7        0.0005920         -            -
 GROUP8            GROUP5        0.0013555         *            -
 GROUP8            GROUP6        0.0021917         *            *
 GROUP8            GROUP3        0.0023694         *            *
 GROUP8            GROUP4        0.0025756         *            *
 GROUP8            GROUP2        0.0037457         *            *
 GROUP8            GROUP1        0.0105035         *            *
 GROUP7            GROUP5        0.0007635         -            -
 GROUP5            GROUP6        0.0015997         *            *
 GROUP5            GROUP3        0.0017774         *            -
 GROUP5            GROUP4        0.0019836         *            *
 GROUP7            GROUP2        0.0031536         *            *
 GROUP7            GROUP1        0.0099114         *            *
 GROUP5            GROUP6        0.0008363         *            -
 GROUP5            GROUP3        0.0010139         -            -
 GROUP5            GROUP4        0.0012202         -            -
 GROUP5            GROUP2        0.0023902         *            *
 GROUP5            GROUP1        0.0091480         *            *
 GROUP6            GROUP3        0.0001777         -            -
 GROUP6            GROUP4        0.0003839         -            -
 GROUP6            GROUP2        0.0015539         *            -
 GROUP6            GROUP1        0.0083117         *            *
 GROUP3            GROUP4        0.0002062         -            -
 GROUP3            GROUP2        0.0013763         *            -
 GROUP3            GROUP1        0.0081340         *            *
 GROUP4            GROUP2        0.0011700         -            -
 GROUP4            GROUP1        0.0079278         *            *
 GROUP2            GROUP1        0.0067578         *            *
```

Table C20. Comparisons Between Turbidity Decay Rates at High Initial Turbidity as a Function of TDS Levels Using Replicate Data

```
Routine: MRANGE        File: HIGHK.MRT       Date: 04-17-2000
Comment: High K


Treatment          Mean         Duncan's Multiple-Range Test
---------         -------
 GROUP8          0.0083854
 GROUP4          0.0097304
 GROUP6          0.0100805
 GROUP7          0.0104087
 GROUP5          0.118238
 GROUP3          0.0129744
 GROUP2          0.0130669
 GROUP1          0.0208367


Standard Error of Treatment Means =   0.00048348


Treatment   vs.   Treatment     Difference     Sig .05    Sig .01
---------         ---------     ----------     -------    -------
 GROUP8            GROUP4        0.0013450         -          -
 GROUP8            GROUP6        0.0016952         *          -
 GROUP8            GROUP7        0.0020233         *          -
 GROUP8            GROUP5        0.0034384         *          *
 GROUP8            GROUP3        0.004S891         *          *
 GROUP8            GROUP2        0.0046816         *          *
 GROUP8            GROUP1        0.0124513         *          *
 GROUP4            GROUP6        0.0003501         -          -
 GROUP4            GROUP7        0.0006783         -          -
 GROUP4            GROUP5        0.0020934         *          -
 GROUP4            GROUP3        0.0032440         *          *
 GROUP4            GROUP2        0.0033365         *          *
 GROUP4            GROUP1        0.0111063         *          *
 GROUP6            GROUP7        0.0003281         -          -
 GROUP6            GROUP5        0.0017433         *          -
 GROUP6            GROUP3        0.0028939         *          *
 GROUP6            GROUP2        0.0029864         *          *
 GROUP6            GROUP1        0.0107561         *          *
 GROUP7            GROUP5        0.0014151         -          -
 GROUP7            GROUP3        0.0025658         *          *
 GROUP7            GROUP2        0.0026582         *          *
 GROUP7            GROUP1        0.0104280         *          *
 GROUP5            GROUP3        0.0011506         -          -
 GROUP5            GROUP2        0.0012431         -          -
 GROUP5            GROUP1        0.0090129         *          *
 GROUP3            GROUP2        0.0000925         -          -
 GROUP3            GROUP1        0.0078623         *          *
 GROUP2            GROUP1        0.0077698         *          *
```

Table C21. Evaluation of the Effects Between TDS Levels on Turbidity Decay Rate Coefficients at Low and High Initial Turbidity Levels Using Replicate Data ∗

Baseline TDS, mg/l vs.	Lower TDS, mg/l	Ref. $F_{2,2}$ stat.	Calcul. F ratio	Ref. $t_{2,0.05}$	Calculated t statistic	Conclusion
2900 TDS, low, (3) reps	1857 TDS, low, (3) reps	19.00	0.3473	2.92	7.155256 (p<t=0.991)	**There is significant evidence to suggest there is a difference**. r^2=0.258
2900	1592	19.00	0.0952	2.92	8.006851 (p<t=0.992)	**There is significant evidence to suggest there is a difference**. r^2=0.087
2900	1320	19.00	7693	2.92	6.267759 (p<t=0.435)	**There is significant evidence to suggest there is a difference**. r^2=0.435
2900	1050	19.00	298.277	2.92	10.90645 (p<t=0.996)	**There is significant evidence to suggest there is a difference**. r^2=0.997
2900	900	19.00	859.479	2.92	8.947774 (p<t=0.994)	**There is significant evidence to suggest there is a difference**. r^2=0.999
2900	750	19.00	5.1426	2.92	11.85531 (p<t=0.997)	**There is significant evidence to suggest there is a difference**. r^2=0.837
2900	600	19.00	0.0303	2.92	10.30032 (p<t=0.995)	**There is significant evidence to suggest there is a difference.** r^2=0.029
1857	1592	19.00	17.7189	2.92	9.522244 (p<t=0.995)	**There is significant evidence to suggest there is a difference**. r^2=0.947
1857	1320	19.00	27.7908	2.92	2.224084 (p<t=0.922)	Not significant evidence to suggest there is a difference. r^2=0.965
1857	1050	19.00	0.4491	2.92	12.36603 (p<t=0.997)	**There is significant evidence to suggest there is a difference.** r^2=0.310
1857	900	19.00	0.4048	2.92	8.637156 (p<t=0.993)	**There is significant evidence to suggest there is a difference.** r^2=0.288
1857	750	19.00	1.9380	2.92	23.58882 (p<t=0.999)	**There is significant evidence to suggest there is a difference.** r^2=0.660
1857	600	19.00	7.0502	2.92	49.74356 (p<t=0.999)	**There is significant evidence to suggest there is a difference**. r^2=0.876
1592	1320	19.00	4.9954	2.92	0.54098 (p<t=0.679)	Not significant evidence to suggest there is a difference. r^2=0.833
1592	1050	19.00	0.1392	2.92	5.511003 (p<t=0.984)	**There is significant evidence to suggest there is a difference**. r^2=0.122
1592	900	19.00	0.1200	2.92	1.66834 (p<t=0.881)	Not significant evidence to suggest there is a difference. r^2=0.107
1592	750	19.00	0.7528	2.92	9.676521 (p<t=0.995)	**There is significant evidence to suggest there is a difference**. r^2=0.429
1592	600	19.00	61.3869	2.92	17.59051 (p<t=0.998)	**There is significant evidence to suggest there is a difference**. r^2=0.984
1320	1050	19.00	0.9703	2.92	2.573672 (p<t=0.938)	Not significant evidence to suggest there is a difference. r^2=0.492
1320	900	19.00	0.8823	2.92	0.971662 (p<t=0.783)	Not significant evidence to suggest there is a difference. r^2=0.469
1320	750	19.00	4.6201	2.92	3.776889 (p<t=0.968)	**There is significant evidence to suggest there is a difference**. r^2=0.822
1320	600	19.00	2.6885	2.92	5.132107 (p<t=0.982)	**There is significant evidence to suggest there is a difference**. r^2=0.729

(continued)

Table C21 (continued) . Evaluation of the Effects Between TDS Levels on Turbidity Decay Rate Coefficients at Low and High Initial Turbidity Levels Using Replicate Data *

Baseline TDS, mg/l vs.	Lower TDS, mg/l	Ref. $F_{2,2}$ stat.	Calcul. F ratio	Ref. $t_{2,0.05}$	Calculated t statistic	Conclusion
1050	900	19.00	1773.655	2.92	9.229637 (p<t=0.994)	**There is significant evidence to suggest there is a difference**, r^2=0.999
1050	750	19.00	7.1671	2.92	9.701098 (p<t=0.995)	**There is significant evidence to suggest there is a difference**, r^2=0.876
1050	600	19.00	0.0549	2.92	5.432727 (p<t=0.984)	**There is significant evidence to suggest there is a difference, r^2=0.052**
900	750	19.00	6.2241	2.92	12.28258 (p<t=0.997)	**There is significant evidence to suggest there is a difference**, r^2=0.862
900	600	19.00	0.0439	2.92	10.40264 (p<t=0.995)	**There is significant evidence to suggest there is a difference, r^2=0.042**
750	750	19.00	6.2241	6.314	15.32576 (p<t=0.979)	**There is significant evidence to suggest there is a difference,** r^2=1
2900 TDS, high, (2) reps	1857 TDS, high, (2) reps	NA	NA	6.314	4.399207 (p<t=0.929)	Not significant evidence to suggest there is a difference, r^2=1
2900	1592	NA	NA	6.314	7.79524 (P<T=0.959)	**There is significant evidence to suggest there is a difference**, r^2=1
2900	1320	NA	NA	6.314	10.98516 (p<t=0.971)	**There is significant evidence to suggest there is a difference**, r^2=1
2900	1050	NA	NA	6.314	10.97686 (p<t=0.971)	**There is significant evidence to suggest there is a difference**, r^2=1
2900	900	NA	NA	6.314	14.10557 (p<t=0.976)	**There is significant evidence to suggest there is a difference**, r^2=1
2900	750	NA	NA	6.314	14.51287 (p<t=0.978)	**There is significant evidence to suggest there is a difference**, r^2=1
2900	600	NA	NA	6.314	14.63904 (p<t=0.978)	**There is significant evidence to suggest there is a difference**, r^2=1
1857	1592	NA	NA	6.314	0.122112 (p<t=0.539)	Not significant evidence to suggest there is a difference, r^2=1
1857	1320	NA	NA	6.314	4.419868 (p<t=0.929)	Not significant evidence to suggest there is a difference, r^2=1
1857	1050	NA	NA	6.314	1.315344 (p<t=0.793)	Not significant evidence to suggest there is a difference, r^2=1
1857	900	NA	NA	6.314	2.976084 (p<t=0.897)	Not significant evidence to suggest there is a difference, r^2=1
1857	750	NA	NA	6.314	2.537947 (p<t=0.881)	Not significant evidence to suggest there is a difference, r^2=1
1857	600	NA	NA	6.314	5.113599 (p<t=0.939)	Not significant evidence to suggest there is a difference, r^2=1

(continued)

Table C21 (concluded) . Evaluation of the Effects Between TDS Levels on Turbidity Decay Rate Coefficients at Low and High Initial Turbidity Levels Using Replicate Data *

Baseline TDS, mg/l vs.	Lower TDS, mg/l	Ref. $F_{2,2}$ stat.	Calcul. F ratio	Ref. $t_{2,0.05}$	Calculated t statistic	Conclusion
1592	1320	NA	NA	6.314	1297.8 (p<t=0.999)	**There is significant evidence to suggest there is a difference**, r^2=1
1592	1050	NA	NA	6.314	6.136 (p<t=0.978)	Not significant evidence to suggest there is a difference, r^2=1
1592	900	NA	NA	6.314	11.76423 (p<t=0.973)	**There is significant evidence to suggest there is a difference**, r^2=1
1592	750	NA	NA	6.314	8.848276 (p<t=0.964)	**There is significant evidence to suggest there is a difference**, r^2=1
1592	600	NA	NA	6.314	29.0443 (p<t=0.989)	**There is significant evidence to suggest there is a difference**, r^2=1
1320	1050	NA	NA	6.314	11.02105 (p<t=0.971)	**There is significant evidence to suggest there is a difference**, r^2=1
1320	900	NA	NA	6.314	1.410463 (p<t=0.804)	Not significant evidence to suggest there is a difference, r^2=1
1320	750	NA	NA	6.314	2.319658 (p<t=0.870)	Not significant evidence to suggest there is a difference, r^2=1
1320	600	NA	NA	6.314	8.376947 (p<t=0.962)	**There is significant evidence to suggest there is a difference**, r^2=1
1050	900	NA	NA	6.314	29.80342 (p<t=0.989)	**There is significant evidence to suggest there is a difference**, r^2=1
1050	750	NA	NA	6.314	13.80976 (p<t=0.977)	**There is significant evidence to suggest there is a difference**, r^2=1
1050	600	NA	NA	6.314	116.5593 (p<t=0.997)	**There is significant evidence to suggest there is a difference**, r^2=1
900	750	NA	NA	6.314	7.454545 (p<t=0.958)	**There is significant evidence to suggest there is a difference**, r^2=1
900	600	NA	NA	6.314	19.26136 (p<t=0.984)	**There is significant evidence to suggest there is a difference**, r^2=1
750	600	NA	NA	6.314	15.32576 (p<t=0.979)	**There is significant evidence to suggest there is a difference**, r^2=1

* 2900 mg/l TDS was evaluated as a baseline of comparison because that TDS level was present on the day of sample collection from Lake Kemp. 1857 mg/l TDS was evaluated as a baseline because it was documented as the TDS concentration which would most likely be present (Wilde 1999).

Appendix D - Water Quality Data from the Analytical Laboratory

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***************************** ENVIRONMENTAL CHEMISTRY BRANCH - DATA REPORTING SHEET  ( PAGE  1 OF   1 ) *****************************


        JOB DESCRIPTION:  LAKE KEMP - PRANGER                    JOB NUMBER:  005M41-00000000       RECEIPT DATE:  16 JUL 99
        CHEM. PRESERVATIVE:                                   TYPE OF SAMPLE:  WATER            COMPLETION DATE:  22 JUL 99


                      COLUMN.........  1              2              3              4
                      ANALYTE........  27             31             34             35
                      PPM............  CA             MG             K              NA

        SAMP #    DESCRIPTION                                                                                                  ROW

        84726     LK 1A          CONC  230      | 64.2       | 6.78       | 629        |                                        1
                                 %REC  103.0    | 96.7       | 99.6       | 107.0      |
                                 DUPL  246      | 68.9       | 7.68       | 673        |
                                 OID   57239201 | 57239201   | 57239201   | 57239201   |


        84727     LK 2A          CONC  247      | 71.1       | 8.43       | 673        |                                        2
                                 %REC           |            |            |            |
                                 DUPL           |            |            |            |
                                 OID   57239201 | 57239201   | 57239201   | 57239201   |


        84728     LK 3A          CONC  232      | 69.8       | 7.81       | 640        |                                        3
                                 %REC           |            |            |            |
                                 DUPL           |            |            |            |
                                 OID   57239201 | 57239201   | 57239201   | 57239201   |


        BL#01     METHOD BLANK 01 CONC <0.200   | <0.200     | <0.200     | <0.200     |                                        4
                                 %REC           |            |            |            |
                                 DUPL           |            |            |            |
                                 OID   57239201 | 57239201   | 57239201   | 57239201   |


        BL#02     LCS 01         CONC  10.1     | 9.99       | 9.98       | 10.0       |                                        5
                                 %REC  101.0    | 99.9       | 99.8       | 100.0      |
                                 DUPL           |            |            |            |
                                 OID   57239201 | 57239201   | 57239201   | 57239201   |


        BL#03     EXTERNAL QC 01 CONC  31.5     | 8.10       | 2.31       | 21.8       |                                        6
                                 %REC           |            |            |            |
                                 DUPL           |            |            |            |
                                 OID   57239201 | 57239201   | 57239201   | 57239201   |


        CA        Calcium                                      MG        Magnesium
        K         Potassium                                    NA        Sodium
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D1

**************************** ENVIRONMENTAL CHEMISTRY BRANCH - DATA REPORTING SHEET (PAGE 1 OF   2) ****************************

JOB DESCRIPTION: LAKE KEMP - PRANGER   JOB NUMBER: 005M41-00000000   RECEIPT DATE: 16 JUL 99
CHEM. PRESERVATIVE: TYPE OF SAMPLE: WATER   COMPLETION DATE: 5 AUG 99

	COLUMN........	1	2	3	4	5	6	
	ANALYTE........	83	84	92	93	96	97	
	PPM...........	SO-4	CL	TSS	TDS	HARDNESS	CNDUCTVY	

SAMP #	DESCRIPTION								ROW
84729	LK 1A	CONC	1073	1219	7	2884	839	1100	1
		%REC	95.2	92.5					
		DUPL	1076	1220		2920			
		OID	20509200	20509200	16159201	16159201	57239201	01159215	
84730	LK 2A	CONC	1073	1218	6	2902	910	1140	2
		%REC							
		DUPL							
		OID	20509200	20509200	16159201	16159201	57239201	01159215	
84731	LK 3A	CONC	1079	1218	16	2884	867	1130	3
		%REC							
		DUPL			14				
		OID	20509200	20509200	16159201	16159201	57239201	01159215	
BL#01	METHOD BLANK 01	CONC	<0.375	<0.375	<4	<4	<1.32	N/A	4
		%REC							
		DUPL							
		OID	20509200	20509200	16159201	16159201	57239201	01159215	
BL#02	LCS 01	CONC	17.7	17.3	N/A	N/A	N/A	N/A	5
		%REC	94.7	92.5					
		DUPL							
		OID	20509200	20509200	16159201	16159201	57239201	01159215	
BL#03	EXTERNAL QC 01	CONC	261	243	N/A	N/A	N/A	1240	6
		%REC							
		DUPL							
		OID	20509200	20509200	16159201	16159201	57239201	01159215	

SO-4	Sulfate		CL	Chloride
TSS	Total Suspended Solids		TDS	Total Dissolved Solids
HARDNESS	Hardness		CNDUCTVY	Conductivity in uMHOS/CM

JOB FILE: 84729   DATE: 05 AUG 99

****************************** ENVIRONMENTAL CHEMISTRY BRANCH - DATA REPORTING SHEET (PAGE 2 OF   2) ****************************

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     JOB DESCRIPTION:  LAKE KEMP - PRANGER               JOB NUMBER:  005M41-00000000    RECEIPT DATE:  16 JUL 99
     CHEM. PRESERVATIVE:                                TYPE OF SAMPLE:  WATER           COMPLETION DATE:   5 AUG 99

               COLUMN......... 7          8          9
               ANALYTE........ 98         99         103
               PPM............ PH         ALKLINTY   TURBDITY
```

SAMP #	DESCRIPTION		PH	ALKLINTY	TURBDITY		ROW
84729	LK 1A	CONC	8.21	88.8	5.5	#1	1
		%REC		95.3			
		DUPL		90.5			
		OID	09159202	20449215	57159216		
84730	LK 2A	CONC	8.27	85.9	5.5	#1	2
		%REC					
		DUPL					
		OID	09159202	20449215	57159216		
84731	LK 3A	CONC	8.27	26.2	3.5	#1	3
		%REC					
		DUPL					
		OID	09159202	20449215	57159216		
BL#01	METHOD BLANK 01	CONC	N/A	<10.0	<0.200	#1	4
		%REC					
		DUPL					
		OID	09159202	20449215	57159216		
BL#02	LCS 01	CONC	N/A	131	N/A		5
		%REC		87.3			
		DUPL					
		OID	09159202	20449215	57159216		
BL#03	EXTERNAL QC 01	CONC	10	136	N/A		6
		%REC	10.06.10.				
		DUPL					
		OID	09159202	20449215	57159216		

```
PH        PH units                            ALKLINTY  Alkalinity
TURBDITY  Turbidity
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FOOTNOTES:
  #1 Units of measure are in NTU.